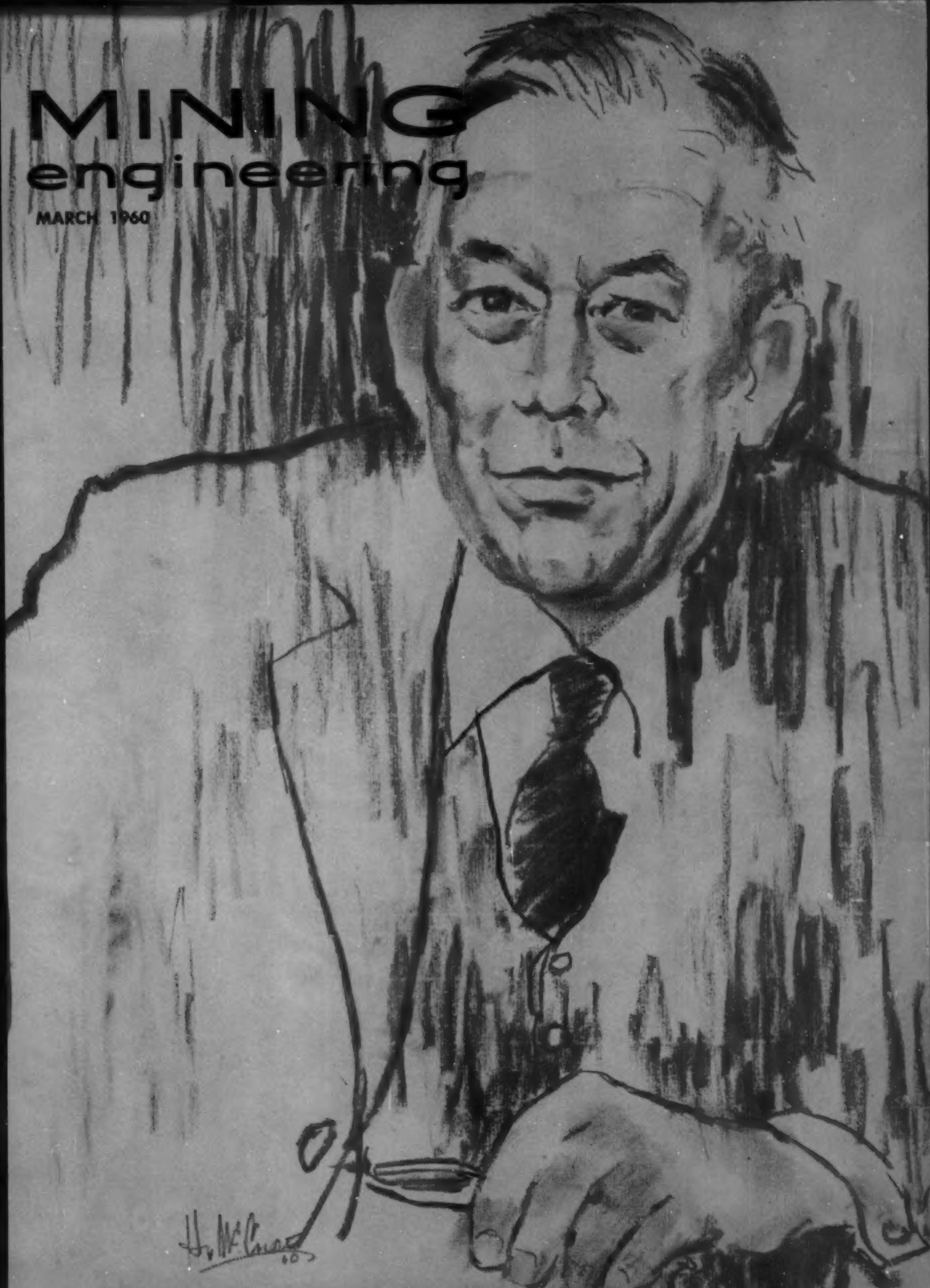
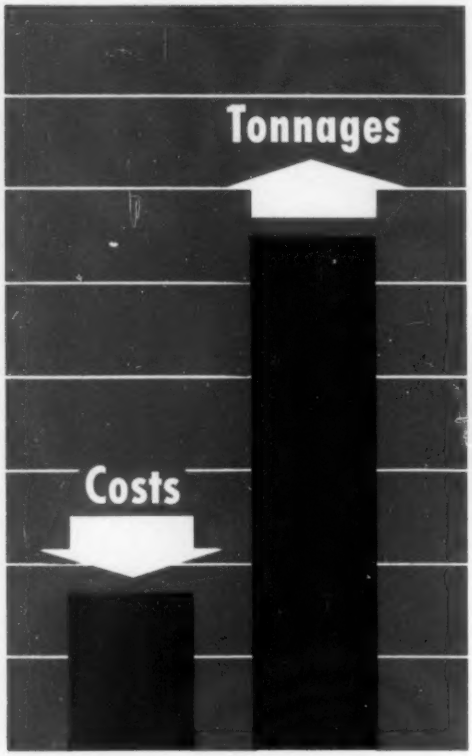
MINING engineering

MARCH 1960





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COMING EVENTS

Apr. 6-9, International Mineral Processing Congress, sponsored by The Institution of Mining and Metallurgy, Church House, Westminster, London, England.

Apr. 6-8, Lead Industries Assn., 32nd annual meeting, Chase-Park Plaza Hotels, St. Louis.

Apr. 7-8, American Zinc Inst., 42nd annual meeting, Chase-Park Plaza Hotels, St. Louis.

Apr. 8, AIME St. Louis Section, tour and lecture; speaker: Demitri Shimkin; subject; "Minerals, A Key to Soviet Power;" Illinois Geological Survey, Illinois Dept. of Mining & Metallurgical Engineering, University of Illinois, Tilden Hall Hotel, Champaign, Ill.

Apr. 11-13, AIME 5th annual Mining, Minerals, and Petroleum Conference, Alaska; speakers: James Boyd, vice president, Kennecott Copper Corp.; J. L. Gillson, 1960 AIME President; University of Alaska, College, Alaska.

Apr. 21-22, AIME Pacific Southwest Regional Metals and Minerals Conference, Ambassador Hotel, Los Angeles.

Apr. 21-23, National Western Mining and Energy Meeting, Denver-Hilton Hotel, Denver. (Meeting date changed.)

Apr. 25-27, CIM Annual Meeting, Royal York Hotel, Toronto.

Apr. 28-30, AIME Pacific Northwest Regional Conference, Sheraton Hotel, Portland, Ore.

May 6-8, AIME Uranium Section, annual symposium, Moab, Utah.

May 9-11, American Mining Congress, Coal Convention, Pittsburgh.

May 9-13, 2nd Southwestern Metal Exposition and Congress, ASM, State Fair Park, Dallas.

May 16-20, International Conference on Strata Control, sponsored by Charbonnages de France, Paris, France

May 19-20, Lake Superior Mines Safety Council, 36th annual conference, Hotel Duluth, Duluth.

June 1-3, Appalachian Underground Corrosion Short Course, West Virginia University, Morgantown, W. Va.

June 5-10, ASME semi-annual meeting, Statler Hilton Hotel, Dallas.

June 10-11, AIME Central Appalachian Section, spring meeting, Martha Washington Inn, Abingdon, Va.

June 10-11, Wyoming Mining Assn., Jackson Lake Lodge, Wyo.

July 11-18, 2nd World Conference on Earthquake Engineering, organized by Science Council of Japan in cooperation with Japan Soc. of Civil Engineers, Architectural Inst. of Japan, Seismological Soc. of Japan; Tokyo and Kyoto, Japan.

Aug. 15-25, International Geological Congress, Copenhagen, Denmark; for information, write Mineralogical-Geological Museum, University of Copenhagen, Øster Voldgade 7, Copenhagen K, Denmark.

Sept. 8-9, SME Coal Div. and AIME St. Louis Section, joint meeting, Chase-Park Plaza Hotels, St. Louis.

Oct. 5-7, AIME Rocky Mountain Minerals Conference, Utah Section host, Newhouse Hotel, Salt Lake City.

Oct. 6-8, 9th National Clay Conference, Purdue University, Lafayette, Ind.

Oct. 10-13, American Mining Congress, Mining Show (metal mining-industrial minerals convention, exposition), Convention Center, Las Vegas, Nev.

Oct. 24-25, AIME-ASME Joint Solid Fuels Conference, Daniel Boone Hotel, Charleston, W. Va.

Nov. 4, AIME Pittsburgh Section, Off-the-Record meeting, Penn-Sheraton Hotel, Pittsburgh.

Nov. 7-10, Soc. of Exploration Geophysicists, annual international meeting, Galveston, Texas.

Nov. 18, American Mining Congress, coal division conference, Penn-Sheraton Hotel, Pittsburgh.

Feb. 26-Mar. 2, 1961, AIME Annual Meeting, Chase and Park-Plaza Hotels, St. Louis.

Apr. 12-14, International Symposium on Agglomeration, sponsored by SME, SPE, and TMS of AIME, Hotel Sheraton, Philadelphia.

Sept. 17-20, Commemoration of the 50th Anniversary of Froth Flotation in the U.S.A., sponsored by AIME: Society of Mining Engineers' Mineral Beneficiation Division, Cosmopolitan Hotel, Denver.

MINING engineering

SOCIETY OF MINING ENGINEERS AIME

VOL. 12 NO. 3 **MARCH 1960**

COVER *Artist Herb McClure presents his portrait of Arthur B. Cummins as MINING ENGINEERING's annual salute to the incoming President of SME. On page 230 readers will learn why this issue also contains the 12 pages that are the basis for the Society's 1960 prospective members brochure.*

ABC

Index to material in MINING ENGINEERING during 1959 will be bound into the May 1960 issue. For why the Index is late, watch for "Drift" in April.

MINING ENGINEERING staff, Society of Mining Engineers, and AIME Officers are listed on the *Drift* page.

Address insertion orders and copy to MINING ENGINEERING, 29 W. 39th St., New York 18, N. Y. Send plates to: MINING ENGINEERING, c/o Lew A. Cummings Co. Inc., 215 Canal St., Manchester, N. H. Published monthly by the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., 29 W. 39th St., New York 18, N. Y. Telephone: PEnnsylvania 6-9220; TWX NY 1-1304. Subscription $8 per year for non-AIME members in the U. S., & North, South, & Central America; $10 all other countries; $6 for AIME members, or $4 additional for members only in combination with a subscription to "Journal of Metals" or "Journal of Petroleum Technology". Single copies, $.75; single copies foreign, $1.00; special issues, $1.50. AIME is not responsible for any statement made or opinion expressed in its publications. Copyright 1960 by the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. Registered cable address, AIME, New York. Indexed in Engineering Index, Industrial Arts Index, and by National Research Bureau. Second class postage paid at New York, N. Y., and at Manchester, N. H. Number of copies printed of this issue 15,700.

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2:13 P.M. The 13"-long charge, containing 94% Spencer N-IV Ammonium Nitrate and 6% fuel oil is about to be detonated.

2:13.000028 P.M. The detonation wave has already spread over nearly one-third of the Spencer N-IV—fuel oil mixture.

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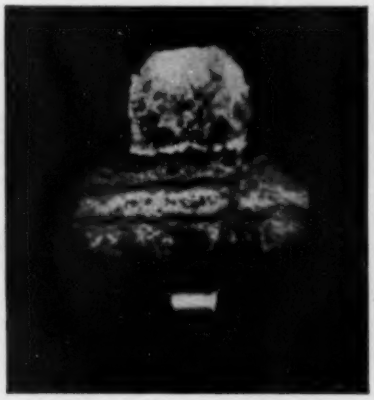
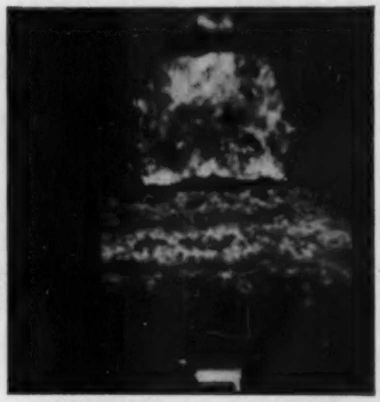


2:13.000088 P.M. Shown here is the great detonation velocity of the N-IV—fuel oil mixture. Yet, N-IV is safe to store and handle.



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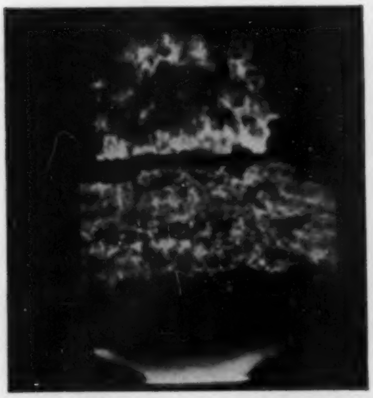

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PERSONNEL

THESE items are listings of the Engineering Societies Personnel Service Inc. This Service, which cooperates with the national societies of Chemical; Civil; Electrical; Mechanical; Mining, Metallurgical, Petroleum Engineers, is available to all engineers, members and nonmembers, and is operated on a nonprofit basis. If you are interested in any of these listings, and are not registered, you may apply by letter or resume and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 5 pct of the first year's salary of a nonmember, or 4 pct if a member. Also, that you will agree to sign our placement fee agreement which will be mailed to you immediately, by our office, after receiving your application. In sending applications be sure to list the key and job number. When making application for a position, include 8¢ in stamps for forwarding application to the employer and for returning when possible. A weekly bulletin of engineering positions open is available at a subscription rate of $3.50 per quarter or $12 per annum for members, $4.50 per quarter or $14 per annum for nonmembers, payable in advance. Local offices of the Personnel Service are at 8 W. 40th St., **New York 18;** 57 Post St., **San Francisco;** 84 E. Randolph St., **Chicago 1.**

In addition to the listings below, ESPS maintains a more complete file of general engineering positions and men available. Contract nearest ESPS office, listed above.

MEN AVAILABLE

Geologist or Mining Engineer, graduate mining engineer, graduate work with geology, age 44. Solid academic background. Seventeen years varied experience in minerals exploration, market analyses, administration. Excellent accomplishment in finding and developing ferrous, nonferrous, uranium, nonmetallic deposits. Interested in raw materials applications, business development, management. Speak Spanish. $12,000. Prefer U. S. Home, California. Se-1307.

Manager, Superintendent, Staff Engineer, Metallurgical Engineer. Diversified experience, open pit mining, beneficiation, hydrometallurgy, pyrometallurgy, agglomeration. Several years top operating staff experience large and medium size operations. Strong background organization, cost reduction and all phases of administration. Domestic and foreign experience. M-520.

Iron Ore Geologist, B.S. in geology, age 32. Eight and a half years exploration and mine geology. Experienced planning and supervision all types of exploration programs and prospect evaluation, includes some experience with base metals and nonmetallics. Location, immaterial. M-942-Chicago.

Mining Engineer, B.S. in mining engineering, age 24. Recent graduate, expect LL.B. degree August 1960. Research in mineral dressing and hydrometallurgy five months. Taught high school six months. Prefer West or Midwest. M-1044-Chicago.

Mine Management Engineer, B.S. in mining, age 37. Fourteen years mine supervision and operation, open pit and underground, construction of mills and facilities. Good record administration, costs, and labor relations. Location, anywhere United States. M-1045-Chicago.

Mining Engineer, B.Sc., age 40. Broad experience production, milling, and engineering holding such positions as mill superintendent and assistant mill superintendent. Desire position with long term prospects. Any location considered. M-521.

Manager, Superintendent, B.S. in mining engineering. Eighteen years varied mining experience, last six in top management. Energetic, good organizer in establishing new mining operations, strong in personnel, labor and community relations, financial and cost accounting. Fluent Spanish. Available immediately. Location, open. M-522.

General Superintendent, assistant. Medium sized underground or surface mine-mill unit. Gold, copper experience. Cyanide milling. All phases administration. Cost conscious. Good organizer. 44; speak Spanish. M1-523.

Geologist, geological engineering, 30. Eight years experience in charge of exploration, examinations, geophysical and geochemical crews on cobalt and copper and mining. $7200. Any location. Home: Idaho. Se-1150.

Manager or Administrative Assistant, B.S. in mining, age 40. Fifteen years experience metal mining operations and management. Experience in development, operations and engineering planning. Desire position with progressive, well established firm. Location, immaterial. M-1040-Chicago.

Mine Manager or Assistant, mining engineer, 44. Twenty years experience in mining, geology, engineering, exploration, management. Qualified to manage open pit or underground; organize engineering or geologic department for operation or exploration company. $10,000. Prefer Northwest. Home: Utah. Se-481.

Superintendent, M.S. in mining engineering, 29. One year underground on various labor jobs; ½ year open pit engineer and one year pit and aerial tramway maintenance foreman. Experience in exploration, survey, development, design, preventative maintenance, reports and supervision. $7200. Prefer: U.S. Home: Nevada. Se-266.

Manager or Research, mining engineer, 42. Have managed producing gold mine and mill and producing uranium mine. Extensive experience in managing programs of exploration for mineral deposits. Capable administrator with good record in dealing with top management. $8,400 to $12,000. Prefer West, South, or Foreign. Home: Canada. Se-1856.

Geologist, Surveyor, M.S. in geological engineering, 34. Two years experience mine geologist, surveyor, mapping on gold, silver, uranium, and civil survey. $7200. Any location. Home: Mexico. Se-1853.

Exploration or Economic Geologist, geological engineer, 42. Twenty years varied exploration background in ferrous and nonferrous deposits both foreign and domestic, specialize in economic geology. $12,000. Prefer: Canada, U.S., or Foreign. Home: Canada. Se-1750.

Production or Management Engineer, mining engineering, 41. Eighteen years experience mining mineral dressing in nonmetallics, underground, open pit, all phases of mineral dressing, exploration, research and development, design and construction. Staff engineering background, costs, estimating and budgeting, reports. Desire production or engineering management position. $12,000. Prefer: West Coast, will consider any. Home: California, Se-1740.

Geologist, geological engineering, 29. Three years varied experience, mining, exploration, ferrous, nonferrous, nonmetallics. Evaluation of mines, prospects for loans or purchase. Speak Spanish. Excellent academic background and references. Presently enrolled in graduate school of business. $6600. Prefer: Western U.S. Home: California. Se-218.

Superintendent, mining engineering, 31. Three years experience planning, supervision of production, drilling, haulage, surveying, exploration on copper, iron ore. $8,400 to $12,000. Prefer: Western U.S. or foreign. Se-446.

Mine Manager or Inspector, economic geologist, 55. Thirty years experience in charge of mining, milling, geology for mining companies. Also inspector on construction of buildings, sanitary sewage disposal plants and stations, utilities for contractors and government. $7800. Prefer: California, Arizona. Home: San Francisco East Bay. Se-381.

Superintendent, mining engineer, 46. Professional license, Colorado. Two years general manager in charge of mercury mine and construction and operation of kiln. Seven years superintendent in charge of open pit mine, concentrator and underground copper, silver, lead, zinc mines. $12,000. Prefer: West. Home: California. Se-216.

Superintendent, mining engineering, 40. Seventeen years experience in charge of mines, mills, surface, underground, open pit; uranium, zirconium, tungsten, lead, zinc, manganese, antimony. $8400. Prefer: West, Southwest. Home: West. Se-1821.

Geologist, geological engineer, 41. Five years experience, evaluation, geology, markets, ore estimates, mapping, prospecting, examination for gypsum, oil, mining properties. $8000. Prefer: West. Home: Montana. Se-1761.

Exploration or Construction Engineer, geological engineering, 49. Twenty-eight years experience as consultant, resident and contract negotiator on highways, airports, mines, railroads and pipelines, bridges for architects and engineers; also soil and rock study and design for builders. $9600. Any location. Home: San Francisco. Se-1816.

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Graduate Assistantships, half-time, in mineral preparation (research), leading to M.S. and Ph.D. degrees; available beginning February, July, or September 1960. Applicants with B.S. in science or engineering desired. Salary, $2280 per year and tuition free. Location, Pennsylvania. W8475.

Assistant Quarry Superintendent, 25 to 35, mining engineer and/or geologist for exploration, development, and expansion of granite quarries. Excellent chance for aggressive man. Salary, open. Location, South. W8422.

Mine Engineers. a) *Mine Engineer* qualified to take over mine and surface surveying. **b)** *Mining Engineer* to handle stope measurements, development measurements, preparation of reports, etc. Salaries dependent on qualifications and experience. Mine produces about 100 tpd from underground operation. Starting salaries $5400 to $6000 year. Location, South. W8415.

Junior Metallurgist, ore dressing background for mining operation. Location. East. W7967.

General Superintendent, mining graduate, with at least five years major supervision in open pit mining operation; thorough knowledge drilling and blasting techniques, power shovel and truck operations, mine railroad systems, and mine planning. Must speak and read Spanish. Latin American experience desired. Salary around $18,000 year. Must be U.S. citizen. Location, South America. F8222.

Assistant Mine Superintendent, graduate mining engineer, with substantial experience in underground mining in South America. Must speak Spanish. Salary, $6600 to $7200 year plus 2½ months salary and benefits as provied by local law. Family housing available; transportation provided for man, wife, and children to age of 12. Three-year contract. Location, South America. F8177.

Executive Vice President, mining engineering graduate, with administrative and at least ten years supervisory metal mining experience. Salary, $15,000 to $18,000 year plus bonus. Location, West. W8163.

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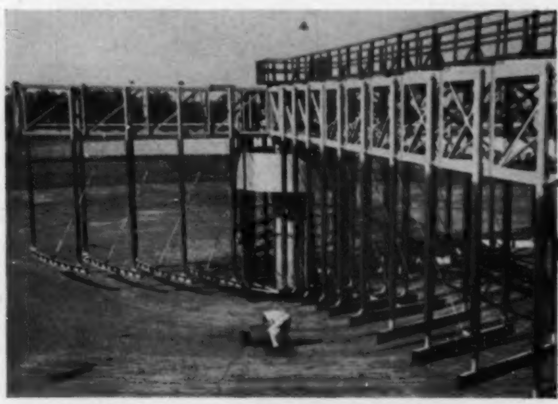

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BOOKS

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Tectonic Sketch Map of North America by W. T. Thom, Jr., *Yellowstone-Bighorn Research Assn.*, 14 Guyot Hall, Princeton, N. J., map, $2.50 postpaid, 1960.—The map shows regional structural features and approximate configuration of the basement surface complex of North America. It is intended to compliment the U.S. tectonic map and geological map of North America. Special inset shows the relation of the Williston Basin to nearby tectonic provinces.

The American Petroleum Industry, by Harold F. Williamson and Arnold R. Daum, *Northwestern University Press*, Evanston, Ill., 864 pp., $7.50, 1959.—The growth of the American petroleum industry from the first commercially successful oil well in 1859 to the end of the age of kerosene illumination is traced in this first part of a two-volume history of the industry, sponsored by the American Petroleum Inst. There is an extensive bibliography at the end of the book. • • •

Aerial Photographic Interpretation, by Donald R. Lueder, *McGraw-Hill Book Co. Inc.*, 462 pp., $17.50, 1959.—The fundamentals of aerial photographic theory and technique are presented, followed by a survey and discussion of the various landforms and rock types, and the practical applications of photographic interpretation in a wide variety of engineering and scientific fields. There is a comprehensive lexicon of land forms and geomorphology dealt with in the photographs. • • •

Physics and Chemistry of the Earth, Vol. III, edited by L. H. Ahrens and others, *Pergamon Press*, 122 East 55th St., New York 22, N.Y., 464 pp., $15.00, 1959.—Two general themes, *origin* and *distribution*, are continued in this third volume of an annual series surveying progress in the interpenetrating fields of physics, chemistry, mineralogy, and astronomy. Types of nuclear reactions involved during the formation of the elements, a survey of uranium and thorium, silicate melt systems, electrical properties of the earth's interior, geochemistry in the USSR, and palaeoclimatology are discussed. • • •

Electrical Efficiency in Industrial Plants, by Edwin S. Lincoln, *F. W. Dodge Corp.*, 119 W. 40th St., New York 18, N.Y., 235 pp., $9.50, 1960.—This book deals with the problems of reducing electric power and lighting costs in industrial plants and commercial buildings with discussions of how to make surveys of load, power factor, voltage, lighting, wiring, and electric protection. The selection, continued use, and maintenance of necessary instruments is gone into. • • •

Symposium on Basic Research, edited by Dael Wolfle, *American Assn. for the Advancement of Sciences*, 1515 Massachusetts Ave., Washington 5, D. C., 308 pp., $3.00, 1959.—Reviews of the concepts and implications of basic research in general are followed by discussions of the relationship of basic research to colleges and universities, government and industrial laboratories, and private research institutes. There is also a section covering the means of securing financial assistance.

Hydrology, by C. O. Wisler and E. F. Brater, second edition, *John Wiley & Sons Inc.*, 408 pp., $9.25, —This volume covers all the basic aspects of the subject and goes on to consider field problems on methods of flood reduction, the evaluation of potential water power on a river, water conservation practices, the determination of spillway and bridge discharge capacities. Two new chapters, the hydrology of semi-arid basins and the effect of snow on the hydrology of an area, have been added to this new edition. • • •

(Continued on page 201)

This three-dimensional map is published by **Aero Service Corp.**, *210 Courtland St., Philadelphia 20, Pa. It is 28x18 in., printed in eight colors on durable vinyl plastic, costs $9.95. There is a map index locating all of the place names shown which slides out from the back of the map. A companion map of the world is also available. The same maps 64x40 in. can be had for $47.50 each.*

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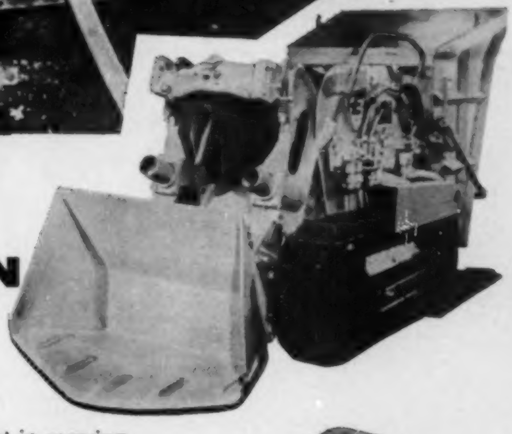

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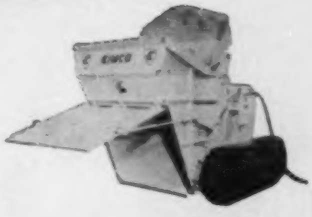

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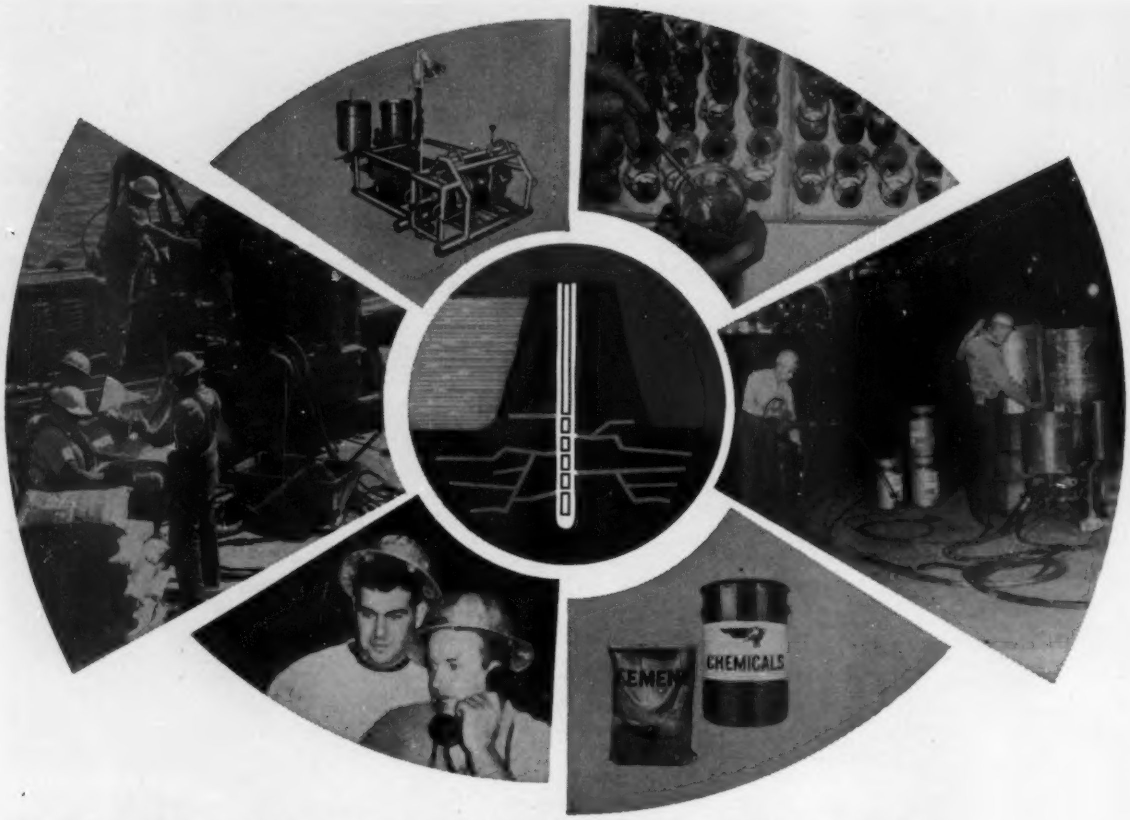

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BOOKS

Continued from page 198

U. S. BUREAU OF MINES

Copies sold through:

Superintendent of Documents
Government Printing Office
Washington 25, D. C.

9R. Types and Definitions of Engineering Drawings, MIL-STD-7, Catalog No. D7.10:7, 40¢, 1959.
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Carte Geologique de L'Algerie
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14. Blvd. Baudin, Algiers

Les formations volcaniques tertiares et quaternaires du Tell Oranais, Bulletin 18, 5.040 Franc, (approx. $10).

Australia

Dept. of National Development
Bureau of Mineral Resources, Childers St.
Turner, Canberra, N.S.W.

The Maranboy Tin-Field, Northern Territory, Bulletin No. 37, gratis, 1958.
New Aconeaceratinae (Ammonoidea) From the Albian and Aptian of Australia, Bulletin No. 54, gratis, 1959.
The Geology of the Coastal Area Between the Lower Gascoyne and Murchison Rivers, Western Australia, Report No. 37, gratis, 1958.

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Dept. of Mines
Box 38, Rundle St. P. O.
Adelaide, South Australia

Truro sheet, approx. 25¢ (2s. 6d.), 1959.

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Director of Mines
Box 177E, G.P.O.
Hobart, Tasmania

The Geology of the Rossarden-Storeys Creek District, Bulletin No. 46, approx. 55¢ (5s.), 1959.
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Victoria

Geological Society of Australia
Melbourne University Press
32 E. 57th St., New York 22, N. Y.

The Stratigraphy of Western Australia, approx. $5 (45s.), 1958.
The Geology of South Australia, approx. $5 (45s.), 1958.

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Melbourne, Victoria

Notes on Laterization and Mineral Deposits, approx. $1.12 (10s.), 1959.
Proceedings of The Australasian Inst. of Mining and Metallurgy, approx. $22.75 annually (£10.10); or $7.50 quarterly (£3.3).

Fiji

Geological Survey Dept.
Suva, Fiji

Geology of North Tailevu, Viti Levu, Bulletin 1, 10s. (approx. $1.40) including map, 7/6 (approx. $1.05) for map alone.

France

Librairie Polytechnique Ch. Beranger
15 Rue des Saints-Peres 15
Paris 6E

Mineraux des Roches, 2nd edition, 1700 franc (approx. $3.40) or 1900 (approx. $3.80) with prospectus.

ABSTRACTS

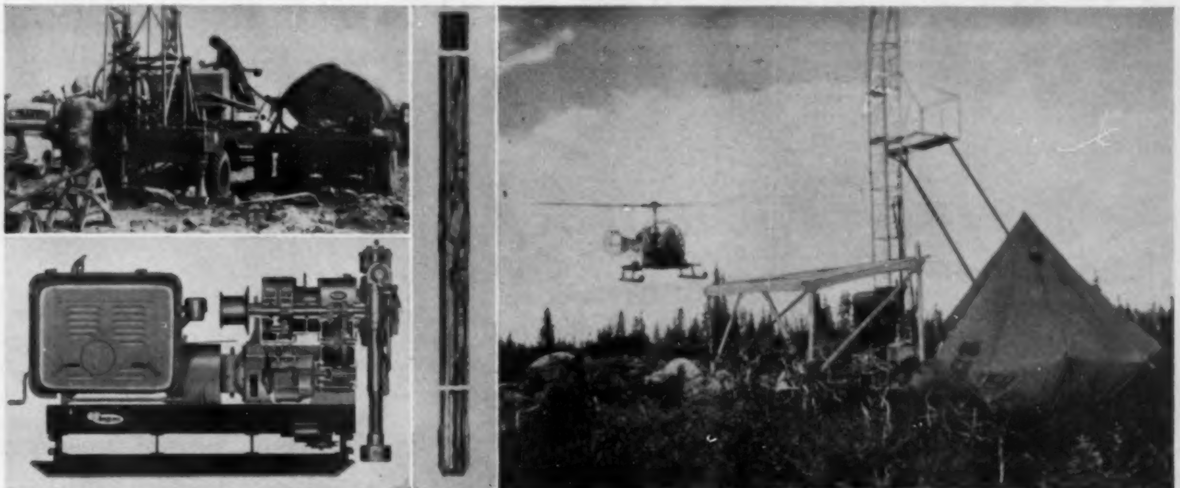
In This Issue: *The following abstracts of papers in this issue are reproduced for the convenience of members who wish to maintain a reference card file and for the use of librarians and abstracting services. At the end of each abstract is given the proper permanent reference to the paper for bibliography purposes.*

Realignment of Predictions Over the Next Five Years (Paley Report Series No. 5) by *S. G. Lasky*—This fifth in the series of papers on discussions of Paley report predictions approximately seven to eight years after its issuance deals with economics and costs. The predictions and record to date are discussed and it is concluded that the Paley projections are reasonable in regard to demands, although adjustments must be made for individual commodities. The writer disagrees with the report in as far as alarm over costs is concerned. **Ref.: Mining Engineering, March 1960, p. 244.**

Steel Supports at Bawdwin Mines, Burma by *F. J. Budin*—Problems of supply in a remote mining region call for ingenuity to overcome the difficulties of terrain and the expenses of importation. The author describes the use of second-hand railroad rails in a Burmese Pb-Ag mine. **Ref.: Mining Engineering, March 1960, p. 246.**

Red China Steps Up Its Geological Service by *Eugene A. Alexandrov*—The article, based on five recent articles from the Soviet Union, surveys the mineral resources of China and recent stepped up exploration activities. Ad-

(Continued on page 204)



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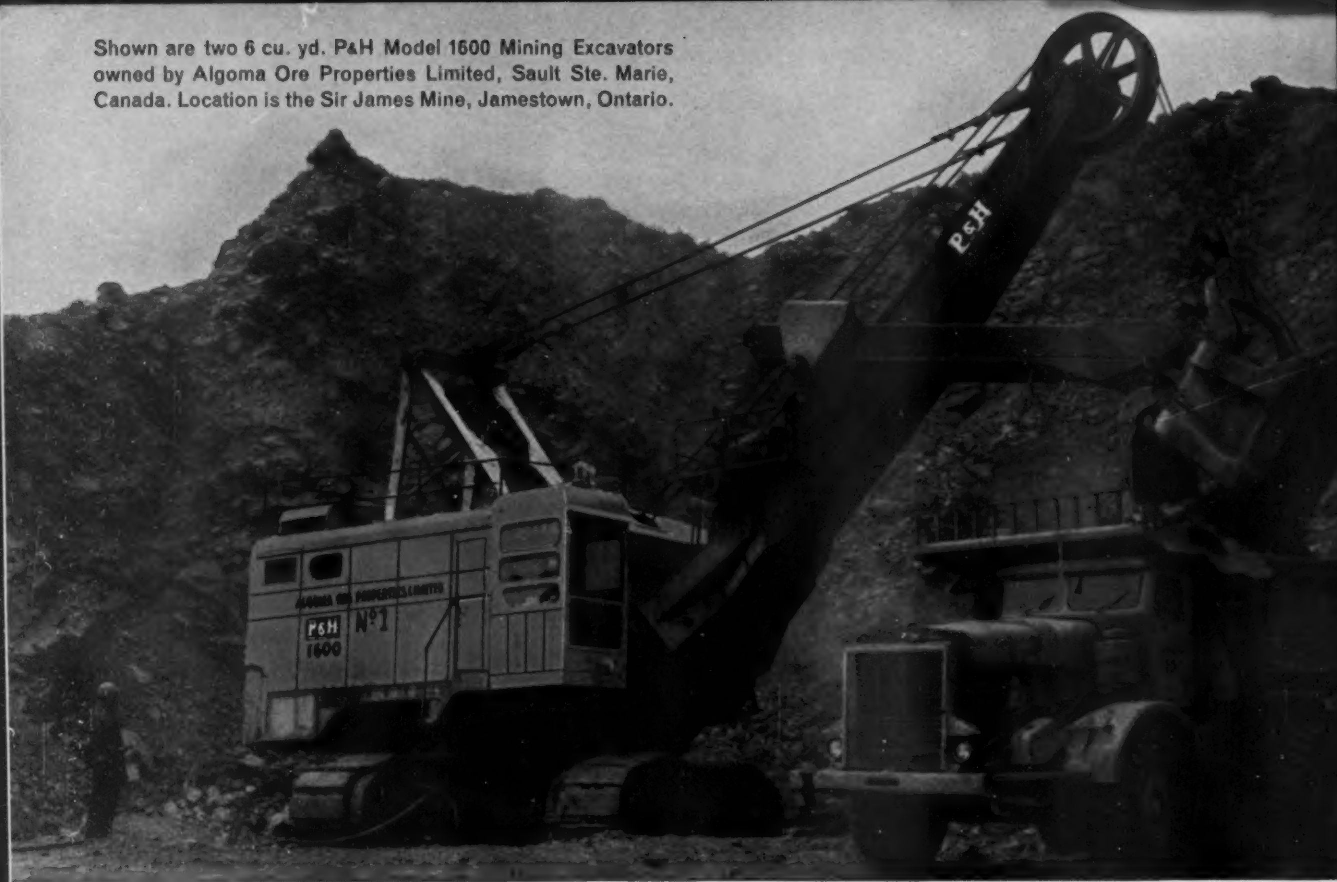
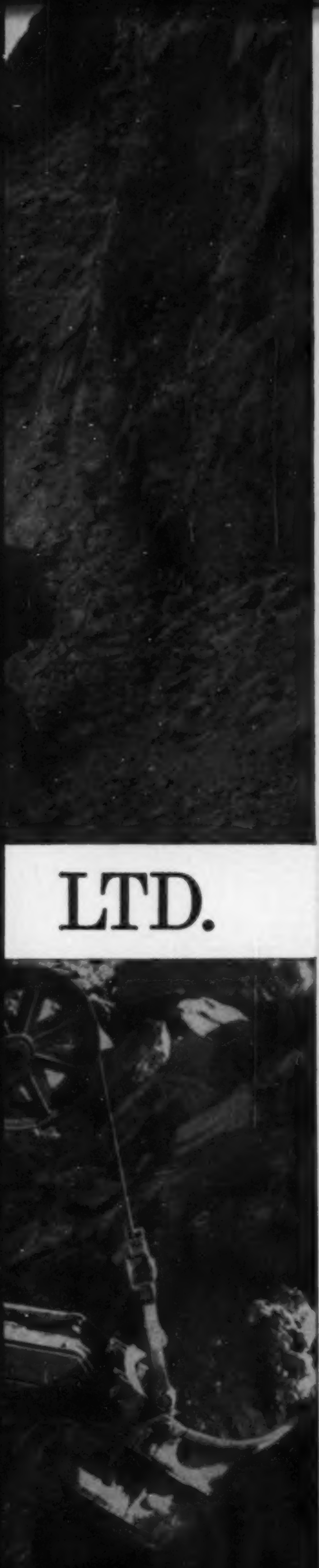


Shown are two 6 cu. yd. P&H Model 1600 Mining Excavators owned by Algoma Ore Properties Limited, Sault Ste. Marie, Canada. Location is the Sir James Mine, Jamestown, Ontario.

AT ALGOMA ORE PROPERTIES,



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ABSTRACTS

Continued from page 201

ministrative and educational activities in connection with mineral resources and exploration are covered. **Ref.: MINING ENGINEERING, March 1960, p. 248.**

Tectonic History of the Basin and Range Province in Utah and Nevada by *John C. Osmond* (TP 48181)—North trending discontinuous ranges consisting of tilted fault blocks with complicated internal structure are characteristic of the area from the Wasatch Range to the Sierra Nevada. Generalized maps and cross sections illustrate the structural evolution of the region.

Beginning in Cambrian time, the Cordilleran geosyncline occupied the western margin of North America. The geosyncline was divided lengthwise into two parallel parts by a tectonic zone which trended north-northeast across Nevada from near Tonapah.

This zone separated shallow water carbonates on the east from deeper water clastics and volcanics on the west during the lower Paleozoic. The tectonic rose as an elongate welt in Mississippian time and expended eastward and westward until, by lower Tertiary time, it included the former area of the geosyncline. Zones of subsidence flanking the welt migrated to east and west as it expanded.

Deformation occurred in various parts of the welt in each period since Devonian with greater intensity in Mississippian, Jurassic-Cretaceous (Nevadan), and Cretaceous-Tertiary (Laramide). Widespread intrusion of granitic stocks occurred in middle Cretaceous and middle Tertiary.

Toward the end of lower Tertiary the relief of the region had been reduced, and most of it was covered by a large volume of essentially horizontal volcanic extrusives. Following the extensive intrusion and extrusion, the crust of the welt adjusted to regional rise by movement along pre-existing fractures, and the present ranges and valleys began to develop.

Movement along faults has continued since Miocene, and many of the valleys have been filled with over 5000 ft of tuffaceous clays and sands. **Ref.: (MINING ENGINEERING, March 1960) AIME Trans., 1960, vol. 217, p. 251.**

Production of Self-Fluxing Pellets in the Laboratory and Pilot Plant by *K. E. Merklin and F. D. DeVaney* (TP 59B88)—A major revolution has been taking place in blast furnace practice. Batch and pilot plant tests have provided information to permit operators of commercial pelletizing plants to proceed with confidence to the production of self-fluxing pellets. As a result of tests it was found that precautions will have to be taken to avoid high pelletizing temperatures, since the large volumes of slagging materials present could quickly form chunks in the furnace. Type of internal bond is different from that obtained in the present product but will provide equal or better resistance to mechanical destruction. It is likely that an acceptable pellet strength will be obtained at a lower furnace operating temperature than that currently being used in commercial plants. **Ref.: (MINING ENGINEERING, March 1960) AIME Trans., 1960, vol. 217, p. 266.**

Geologic Setting of the Nickel Occurrences on Jumbo Mountain, Washington by *Joseph W. Mills* (TP 59I227)—Discovery of nickel on Jumbo Mountain, Snohomish County, Washington, focused attention on the area in 1956. The paper covers the geology of the area, touching upon the following structures: sedimentary rocks, ultrabasic and basic igneous rocks, gabbro, acidic igneous intrusives, and faults. The geology of the nickel deposits is discussed. **Ref.: (MINING ENGINEERING, March 1960) AIME Trans., 1960, vol. 217, p. 272.**

SME Meeting Papers: *The following abstracts of papers presented at SME meetings are given for your information. Copies of these papers are available* **only if followed by a preprint order number.** *These preprints are obtained on a coupon basis. The coupon books may be purchased from SME headquarters for $5.00 a book (10 coupons) for members of AIME or $10.00 a book for nonmembers. Each coupon, properly filled out, entitles the purchaser to one preprint. Mail completed coupons to Preprints, Society of Mining Engineers, 29 W. 39th St., New York 18, N. Y.*

Project Plowshare—The Peaceful Uses of Nuclear Explosions by *Wilmot N. Hess*—Results of recent underground tests by the Atomic Energy Commission indicate possible applications of nuclear energy to the mining industry. Our experience with these underground explosions shows us they are safe and they can produce several useful effects. The fact that large volumes of rock can be crushed this way lead us to consider applications to various mining problems. The heat reservoir created by an explosion might be used to produce steam and power or to promote the recovery of oil. Other possible uses include the development of petroleum reserves, water resources, and low grade ore deposits that are currently unused. The mining industry can help us by suggesting situations that might be exploited by this new type of explosive and providing know-how to carry out these projects. **AIME Annual Meeting, New York, February 1960.**

Deep-Sea Geology by *Bruce C. Heezen*—Manned exploration of the moon and the near planets is now seriously contemplated, yet two thirds of the surface of the lithosphere remains nearly unknown. The sea floor is our greatest geographical frontier. The promise of new exploitable mineral resources is far greater on the sea floor than in outer space. In a few years, mining geologist may need a working knowledge of geography of the floors of the oceans. I will describe the new methods of deep-sea exploration, give a new look at the floor of the Atlantic and discuss the tectonic implications of some of the recent discoveries in deep-sea geology. **AIME Annual Meeting, New York, February 1960.**

Solution Extraction of Salt Using Wells Connected by Hydraulic Fractures by *Carl A. Bays, W. C. Peters, and M. William Pullen*—During the past three and a half years considerable improvement in the techniques of solution extraction of salt has been made by the use of wells which are cross-connected by hydraulic fracture at the base of the salt. Fracture is initiated by the application of hydraulic pressure. Underreaming and perforating techniques are used to control initiation. The fracture is then extended by continuous pumping until a pressure communication is obtained. Pressure communication is followed by washing-through to obtain a low-pressure connection. Well construction using non-shrinking cements that will bond with the salt and with associated strata is essential to the process. The connecting procedure described permits solution to attack the salt deposit from its base upward, thereby permitting greater recovery, fewer well repairs, better saturation of brine, and overall economy of development and operation. The fracture method of cross-connection requires special pumping of the fluid and is limited by present experience to initial well spacings up to about 1200 ft. The method has been used in bedded salts and is applicable for wells in salt domes. **AIME Annual Meeting, New York, February 1960. 60H100**

Iron Ores of the Nimba Range, Liberia, West Africa by *Martin G. Beyer*—Exploration in the central and southern parts of the Nimba Range in the northern part of the Central Province, Republic of Liberia, has during the last few years exposed an iron field with occurence totaling several hundred million tons of highgrade iron ore. There are three main types of ore, all embedded in lowgrade steeply tilted itabirite. A description is given with a discussion on the highgrade ore genesis. The largest deposit, the main orebody, contains more than 200 million tons of dark blue laminated ore, predominantly martite. This goes to a depth of more than 600 m below the highest outcrops along the crest of the range, which has an elevation of 1200 to 1300 m above sea level. The origin is probably due to leaching by supergene solutions during the pre-Cambrian. The other two ore types, a brown goethite-coated martite and the crust ores (lateritic ironstone and canga), do only go to shallow depths and are formed by lateritization processes related to successive erosion levels, ranging probably from the Cretaceous to recent times. **AIME Annual Meeting, New York, February 1960.**

Practical Problems in Drilling Mine Shafts by *Victor Zeni*—This paper briefly describes the history of sinking mine shafts by rotary drilling. It covers the use of these shafts and their limitations. The problems encountered in drilling operations are touched upon. The economics of rotary drilling shafts from the viewpoint of the mine operator and drilling contractor are discussed. **AIME Annual Meeting, New York, February 1960.**

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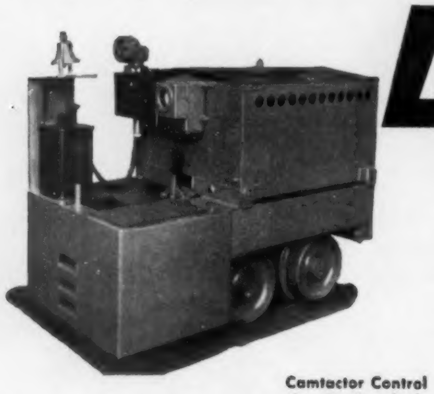

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The Status of the Airborne Gravity Meter by *Lloyd G. D. Thompson*—Work done to date on the airborne gravity meter problem shows that aerial gravity results are possible which are of a quality suitable for geodetic and regional studies. The application of aerial gravity measurements is illustrated by an anomaly contribution curve derived mathematically using a zonal method and a zone chart which shows the effect of surface anomalies at a point above the surface. The limitations in the existing state of the art of an airborne gravity meter make the detection of small anomalies unfavorable at this time for geophysical prospecting, but the successful application in the future is not precluded. **AIME Annual Meeting, New York, February 1960.**

Tri-State Zinc's Bowers-Campbell Operation by *Larry G. Hayes*—Tri-State Zinc's Bowers-Campbell mining operation at Timberville, Va., is of special interest because of the low unit costs obtained by use of heavy diesel equipment underground. The orebody is a nearly vertical dipping breccia lens which measures approximately 700 ft long; up to 100 ft wide, and 475 ft in depth. Access to the orebody is by a 17x15-ft inclined adit 4328 ft in length. The adit was driven in a series of straight-aways and curves which make it loop as it advances downward on a 10 pct grade. The ore is mined by a room and pillar method which divides the lens into horizontal cuts 40 ft high separated by 40-ft floor pillars. These horizontal cuts are divided into 50-ft rooms running the full width of the orebody and separated by vertical pillars 25 ft wide. A 20-ft top slice is removed from each room and the remainder of ore in the room is taken by benching. Pillar recovery will be by caving. Drilling of drift and slabbing rounds is done by crawler-tractor or truck-mounted jumbos, while bench drilling is done by an air-trac. A diesel shovel and end loaders are employed to load broken ore into diesel dumptors trucks which haul it directly to the crushers on the surface. Average production of the Bowers-Campbell mine is 750 tpd. Total mining and milling costs average $1.70 per ore ton. **AIME Annual Meeting, New York, February 1960. 60AU77**

Process Control in Uranium Mills-How Far Can Automation Go? by *John W Barnes*—In seeking cost reductions, control methods are a fertile field because they significantly affect labor and other costs. While process control in uranium mills is excellent by the evidence of high recovery, the costs seem high to those familiar with extractive operations for other metals. To some extent this high cost is inevitable, because of: exacting quality control; the technically complicated recovery processes; poor control over grade and nature of mill feed; special problems arising out of the radioactive property of the material. Practices used in uranium mills, and the limitations indicated for instrumentation and automation, are discussed. Observations indicate that any large investment in automatic controls should be preceded by a careful study of their reliability and maintainability, and estimate of the net income after taxes under existing depreciation rules. Smaller plants may find it more profitable, or at least less risky, to concentrate their efforts on the possible reduction of some control problems, and to development of a stable force of highly skilled employees. The observed experience does not inspire optimism that ore-dressing plants can be extensively automated, although certain unit operations do offer a challenge for improvements in instrumentation and machine design. **AIME Annual Meeting, New York, February 1960. 60B96**

Orientation Potentials of Monolayers Adsorbed at the Metal/Oil Interface by *Frederick M. Fowkes*—The potential resulting from oriented dipoles in an adsorbed monolayer of surface-active agent has been measured at the oil/metal interface with the vibrating condenser method, using a thin layer of the oil solution on the metal plate. The potentials of tight packed monolayers are found to be the same as for insoluble monolayers of the same compound at the air/water intreface. Rates of adsorption are easily measured by this method and are found to be from one to many orders of magnitude slower than calculated for diffusion controlled adsorption, the rate depending on both the type of agent and the type of metal. Rapid adsorption is assumed to indicate "strong" adsorption. Equilibrium potentials are used to measure fractional coverage and its concentration-dependence. In cases where strong adsorption is indicated by tight-packed monolayer potentials and by little concentration-dependence of the equilibrium potential, the rates of adsorption were rapid. Thus the strength of adsorption is measurable by both rates and equilibrium potentials. *Joint Meeting, SME, MBD-American Chemical Society, Div. of Colloid Chemistry, Atlantic City, N. J., September 1959.*

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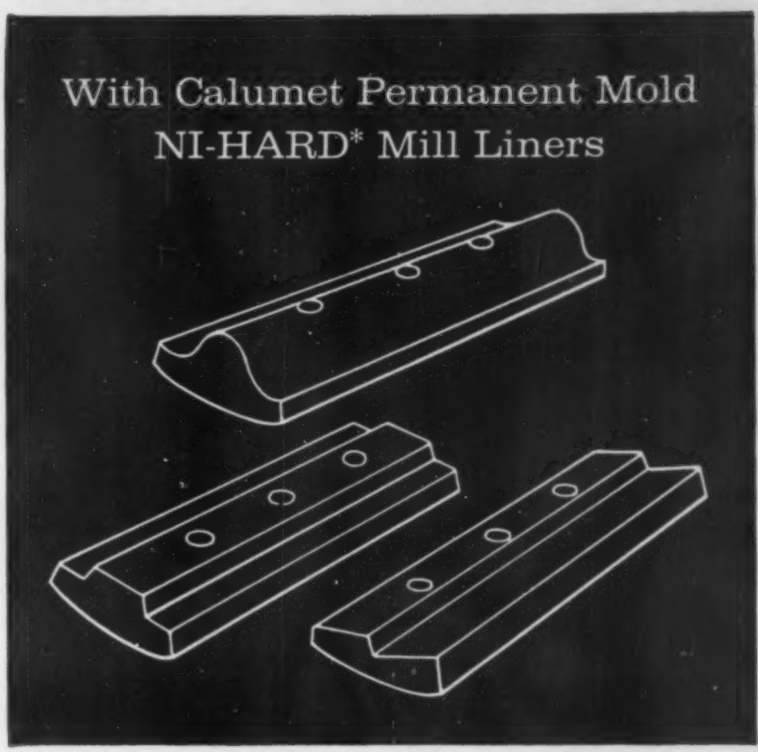

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An 8-in., 27 lb Durolite block for 1-in. synthetic fiber or manila rope is now available from *Sauerman Bros.* Block has tapered roller bearings, wide flange sheave, and wide throat housing. **Circle No. 1.**

Motorized Scaffold
A unique motorized scaffold capable of expanding rapidly to large work platform at desired heighth up to 14½ ft is offered by *Athey Products Corp.* Moving on rubber tires or

rails, the Moto-Scaffold transports men and material through tunnels and to high areas. **Circle No. 2.**

Differential Scanner
Urinco's Model VLS Differential Scanner allows radiometric assaying of U_3O_8 content of ore within 1-ft radius behind mining face or in stock piles. Filter shield permits accurate determinations in areas of high or low radiation background. $221 F.O.B. Grand Junction, Colo. **Circle No. 3.**

Shakeout
H-R Trackside, new railroad car shakeout by *Hewitt-Robins*, utilizes an hydraulic cylinder and vibrating head to shake an entire car of compacted or frozen material. The shakeout, mounted in fixed position beside track, is push-button controlled for safe operation. Designed for unloading one to ten hopper cars daily for coal, aggregates, ores, etc. **Circle No. 4.**

Refractory Heat Exchanger Design
Trefoil refractory heat exchanger design developed by *Harbison-Walker* for rotary limestone and lime sludge kilns extends lining life by reducing excessive accretions development in high temperature zones with certain fuels. Fuel savings and increased production are also reported. **Circle No. 5.**

Tandem Scraper System
A practical tandem scraper system has been devised by *LeTourneau-Westinghouse Co.* allowing owner to double or halve his equipment capacity at will. Allows faster loading without need of more powerful pushers when capacity doubled.

Electric controls transmit power to rear scraper. Tandem is highly maneuverable as rear scraper rides "piggyback" on front scraper permitting second scraper to turn full 90° relative to front scraper. Adaptable to most Tournapull scraper combinations in use at modest cost. **Circle No. 6.**

Drill Rig
Schramm has introduced Model C42 Rotadrill, a self-contained single-unit drill rig mounted on a self-propelled crawler, for rotary and blast hole drilling. Featured are

one-man operation, complete hydraulic controls, variable speed hydraulic drilling motor, plus mounted rack for extra drill steel. Wide tracks give drilling stability and allow movement with mast in vertical position. **Circle No. 7.**

Machinery Safeguard
Roto-Guard, by converting rotary motion into an electrical signal, provides reliable protection for conveyors, feeders, or process machinery where stopping or slow-down may cause damage. Now being produced by *The Bin-Dicator Co.*, the device gives a signal impulse to energize alarm systems or operate control switches automatically. **Circle No. 8.**

Wheel Loader
Cat No. 944 Traxcavator, first of all-new line of wheel loaders by *Caterpillar Tractor Co.*, emphasizes operator-safety plus new features.

Unit has lift arms and hydraulic cylinders forward of controls so bucket is never overhead of operator. Also has new high-capacity hydraulic system, 2-speed power shift transmission, choice of engines and buckets, and complete line of attachments. **Circle No. 9.**

Wedge-Wire Screen
Rima, a wedge-wire screen of stainless and carbon steels, has been introduced by *Cross Perforated Metals* for screening, sifting, dewatering, sizing, and washing and filtering minerals. Thinner wire profiles not previously available permit more wires per working screen surface and greater screen capacity. Furnished in rectangular, oblique angled, round and oval beds with sharp or round bends. Other shapes also available. **Circle No. 10.**

Heavy Duty Conveyor Belts
Greater payloads of all materials are now possible with new heavy duty conveyor belts designed for 45° idlers by *Raybestos-Manhattan.* Outer plies of belt are of special weave high-strength synthetic fabric of controlled elasticity allowing belt to transport heavy-weight material without ply or cover separation. **Circle No. 11.**

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(22) **CRANE-EXCAVATOR:** A 24-page catalogue (No. 730-CG-2) on the American 300 Series Crawler Crane-Excavator issued by *American Hoist & Derrick Co.* describes and illustrates the machine's versatility on many different type jobs such as crane, magnet, clamshell, dragline, shovel, and backhoe.

(23) **MANUAL:** *Texas Gulf Sulphur Co.* has announced publication of a comprehensive SULPHUR MANUAL to benefit firms using or planning to use sulphur, solid or molten. Divided into four sections—The Sulphur Industry, Shipping of Molten Sulphur, Handling and Storage of Molten Sulphur, and Analysis of Sulphur, plus an appendix entitled Physio-Chemical Properties of Sulphur—the manual is constructed to accommodate additional sections as published.

(24) **FRONT END LOADER:** The Eimco 126 Front End Loader is the subject of Bulletin L-1092 by *The Eimco Corp.* 16 specific features contributing to peak performance are given with tractor specifications in English and metric measurements.

(25) **TRANSIT-MIX PLANT:** Installation and operation of the Gopher, a portable transit-mix plant with an hourly production capacity of 70 cu yds of aggregate and cement, is described in a bulletin of *the C. S. Johnson Co.*, division of *Koehring Co.*

FREE LITERATURE

(26) **OUTRIGGERS:** A 4-page bulletin describing hydraulic outriggers on Lorain Moto-Cranes is now available from *Thew Shovel Co.* Outriggers use curved beams with attached floats that automatically adjust to ground level.

(27) **TUBE FITTINGS:** A practical guide in selecting HiSeal Tube Fittings is available in a 46-page illustrated catalogue (No. 3108) issued by *Imperial Brass Mfg. Co.* Technical and dimensional data is supplied for wide range of applications. Corrosion guide, hydraulic and compressed air formulae, flow determination chart, and maximum working pressures are included.

(28) **CHAIN MANUAL:** A comprehensive illustrated manual to aid selection of chain for conveying and elevating is now available from *Moline Malleable Iron Co.* Correct application of chains to conveyor systems, attachments, comparison charts of principal features of various chain types, graphs of friction coefficients and other data is provided.

(29) **VIBRATORY FEEDERS:** A 32-page catalogue of vibratory feeders has been issued by *Syntron Co.* Complete information provided for small, heavy, and extra-heavy-duty standard electromagnetically vibrated feeders plus data on spreader feeders, furnace feeders, picking tables, conveyors, and others.

(30) **WHEEL LOADER SELECTION:** An interesting 9-page article entitled "Fitting A Wheel-Type Loader to Job Needs" is now available from *Caterpillar Tractor Co.* Providing an outline and benchmarks for the practical selection of wheel loaders, the study highlights the need for optimum balance of productivity and durability of such equipment.

(31) **PUMPS:** *Goulds Pumps* has issued Bulletin No. 725.5 describing five sizes of heavy duty solids handling pumps designed to meet the most severe operating conditions. Pumps are especially adapted to handle solid suspension fluids and thick liquids in temperature to 350°F. and working pressures to 400 lbs.

(32) **ENGINES:** *International Harvester Co.'s* revised folder CR-824-I, "International Engines and Power Units", contains information on 24 models of diesel and gasoline engines from stripped to complete power units.

(33) **PERMANENT MAGNETIC PULLEYS:** Description and application of permanent magnetic pulleys is contained in a recent brochure from *Eriez Mfg. Co.* Two basic designs with choice of magnetic strengths, diameters, and belt widths plus guides to proper pulley selection are included.

(34) **GRATE COOLERS:** Design, adaptability, and other pertinent information for horizontal-grate and inclined-grate coolers and associated clinker-breaker is supplied in an 8-page illustrated bulletin (CO-7) by *Fuller Co.*

(35) **SCREW CONVEYORS:** A comprehensive 76-page illustrated book devoted to the versatility and selection of screw conveyors, screw feeders, and components have been released by *Link-Belt Co.* Book 2989 shows application of screw conveyors for wide range of purposes and includes an extensive list of materials for which they may be used.

(36) **PORTABLE COMPRESSOR:** A 4-page bulletin from *Le Roi Division of Westinghouse Air Brake Co.* depicting 22 features of model 125RG2

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3

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Students should write direct to manufacturer.

portable rotary compressor including their "double-life" rotors in both low and high pressure cylinders is available. Capable of delivering 125 cfm of air at 100 psi, the unit's 100% modulating control, thermo-by-pass valve and low engine oil cut-off switch are explained.

(37) CONTROLS: *Partlow Corp.* has issued a 4-page booklet on all-electric explosion-proof controls, indicating, non-indicating, and recording. Information on their pneumatic controls of indicating and recording types for hazardous locations is included.

(38) PAYHAULER: A 16-page color catalogue describing the 19-ton International Model 65 Payhauler has been published by *International Harvester Co.* Details of the triple-strength light-weight corrugated body, 250 hp diesel engine, enclosed power steering system, safety and comfort features, and grade-haulage relationships are supplied.

(39) MAGNETIC PULLEYS: Details of a new line of Ceramox V Perma-Pulleys and a line of redesigned and improved electromagnetic pulleys is contained in catalogue C-2000 from *Dings Magnetic Separator Co.* Ceramox V, a new ceramic magnet material said to provide greater permanent magnetic field intensity than other magnet materials, is featured. Accompanying chart assists proper selection of electric or non-electric magnetic pulleys in relation to belt speed, belt width, and burden.

(40) CONSTRUCTION EQUIPMENT CATALOGUE: The *Caterpillar Tractor Co.* has recently published a 20-page catalogue of its complete line of earthmoving equipment and diesel engines. Contents include pictures and brief specifications of motor graders, tractors, bulldozers, rippers, Traxcavators, scrapers, pipelayers, marine engines, and auxiliary equipment.

(41) BELT DRUM FILTER: Bulletin F-2053 from *The Eimco Corp.* describes the savings which Eimco-belt continuous belt drum filter permits in use of chemical reagents, drying costs, maintenance, filter media costs, and cloth changing time, as well as continuous filtration of slurries not previously able to be filtered on vacuum drum filters. Several pages are devoted to actual operating results in industry.

(42) SEMI-AUTOMATIC HOISTS: If lower costs, faster results, and greater safety during raise driving is of interest, request a recent booklet published by *Vulcan Iron Works* (Denver) describing semi-automatic hoists. 70% footage increase with 50% cost savings over conventional methods, better ventilation, continuous overhead cover, no overhead timbering, no stripping of timber, no chute or manway hazard are advantages cited.

(43) FLOTATION INDEX: The "Twenty-Ninth Annual Addition to the Flotation Index", containing information published through 1958, is now available from *The Dow Chemical Co.* The Flotation Index, a bibliography of articles appearing in leading mining publications, is divided into three sections dealing with flotation research, general mineral dressing, and milling operations.

(44) MULTIPLE-TUBE COOLER: How *Allis-Chalmers* multiple-tube cooler saves money five ways is told in leaflet No. 22B9290. The cooler is designed to provide low-cost cooling of fine, soft or granular materials, including lime, dolomite, magnesia, alumina, clays, fuller's earth, etc.

(45) PORTABLE TANDEM-CRUSHER: Complete information about a portable tandem-crusher aggregate plant, newly designed to include a twin-jaw primary crusher and other new features, is contained in an 18-page illustrated bulletin issued by *Iowa Mfg. Co.*

(46) FLOCCULANTS: To assist in proper selection and more efficient use of flocculents, *American Cyanamid Co.* has issued a 20-page booklet entitled "Cyanamid Flocculants". Divided into four main sections—available products, general information, commercial applications, and laboratory testing procedures with bibliography—it describes the chemical and physical properties of flocculents plus detailed information on their preparation and employment.

(47) MIXER SETTLER UNIT: Design of a compact mixer settler unit used in the solvent extraction process at many new uranium mills is described and illustrated in Bulletin No. M7-F65 from the *Denver Equipment Co.*

(48) MOBILE WELDING UNIT: A 4-page folder describing the International TD-15-500-1 Paywelder is available from *International Harvester Co.* The rig carries two 325-amphere dual welders with four leads and constitutes a compact 120 hp package capable of traversing swamps and mountains to job sites.

(49) DIESEL ENGINE MAINTENANCE: A 24-page booklet on diesel engine maintenance has been issued by *Cummins Engine Co.* The booklet, "Ten Maintenance Steps", tells power users how to increase equipment availability, reduce operating costs, and obtain better engine performance.

(50) GRINDING RODS: *The Colorado Fuel and Iron Corp.* has issued a 13-page illustrated booklet entitled "Grinding Rods, Their Use and Manufacture" which describes grinding rod requirements and specifications, considerations when ordering rods, and rod mill practices. Some production problems of rod mills, their possible causes, and required adjustments are also described.

(51) PORTABLE GENERATOR: A 2500 watt, 180 cycle portable engine generator which allows appreciable fuel savings, longer engine life, and lower maintenance cost plus adaptability to 230 v ac and 110 v dc is described in available literature from the *Wincharger Corp.*

(52) PYROMETER CALIBRATING SET: The *Pyrometer Instrument Co.* has designed an Optical Pyrometer Calibrating Set to permit accurate and simultaneous calibration of any two optical pyrometers. The Test Set eliminates uncertainties and provides an easy method for calibrating all types of optical pyrometers in the field.

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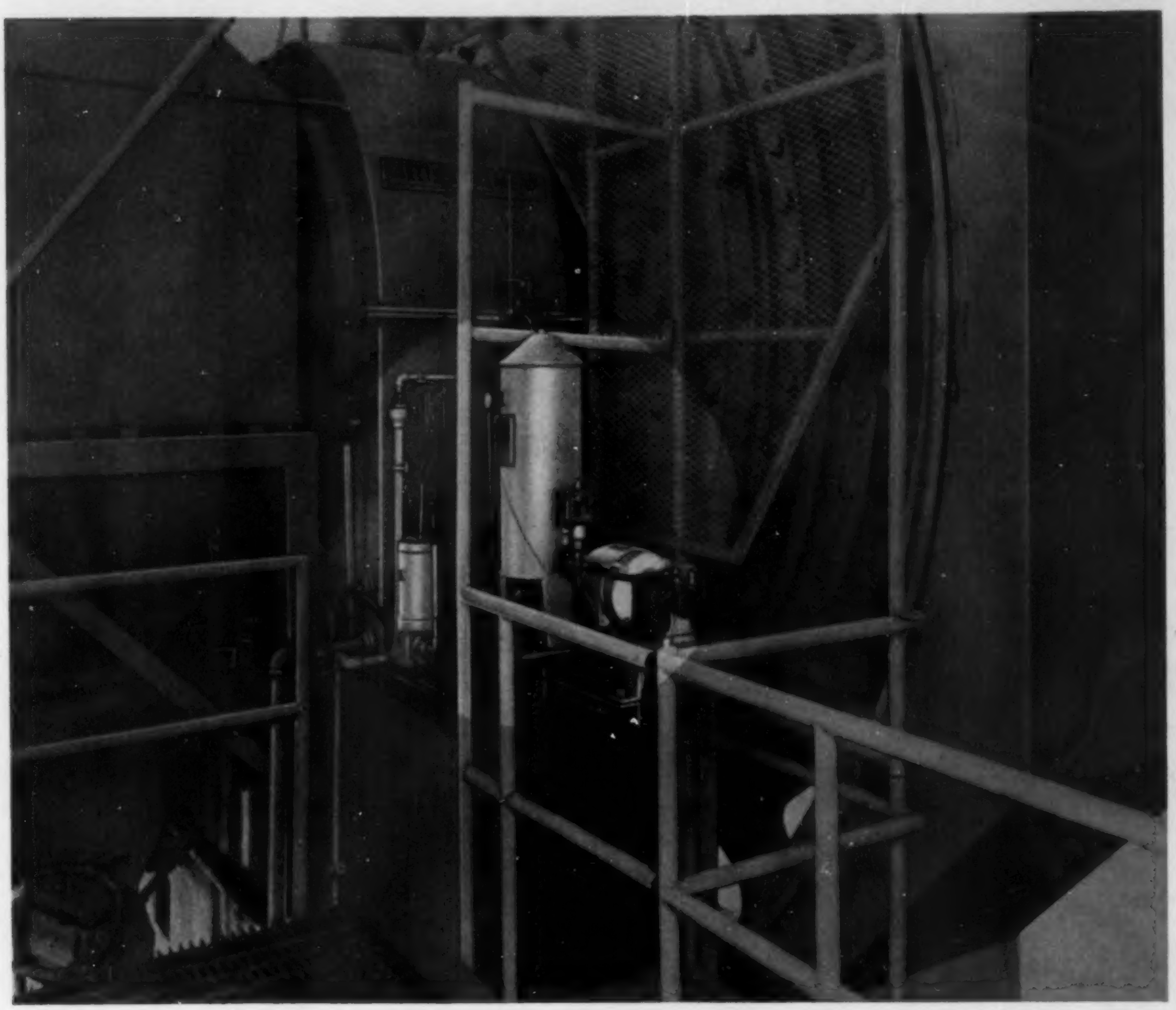


Floating start, ride and stop for big mills

New Lubritrol system provides constant lubrication for trunnion bearings

The new, bigger A-C grinding mills actually *float on oil.* Process industries are grinding out bigger profits because of *Lubritrol* constant lubrication system. No bearing-wearing starts. No dry sliding after shutdown. Less wasted horsepower. All functions of the *Lubritrol* system are automatic…controlled by foolproof pressure gauges and switches. The system is filtered to remove contaminants.

When you modernize your operation, check the benefits of an Allis-Chalmers grinding mill — the only mill that gives you the positive protection, the operating and maintenance economy of *Lubritrol* constant lubrication. *See your A-C representative, or write* **Allis-Chalmers,** *Industrial Equipment Division, Milwaukee 1, Wisconsin. In Canada, write Canadian Allis-Chalmers Ltd., Box 37, Montreal, Quebec.*

Lubritrol is an Allis-Chalmers trademark.

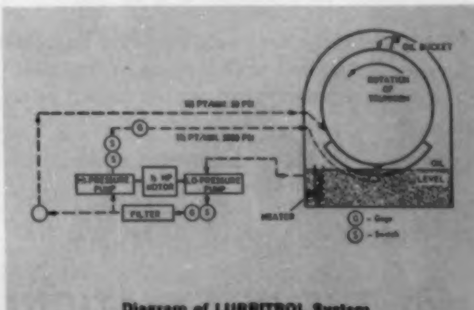
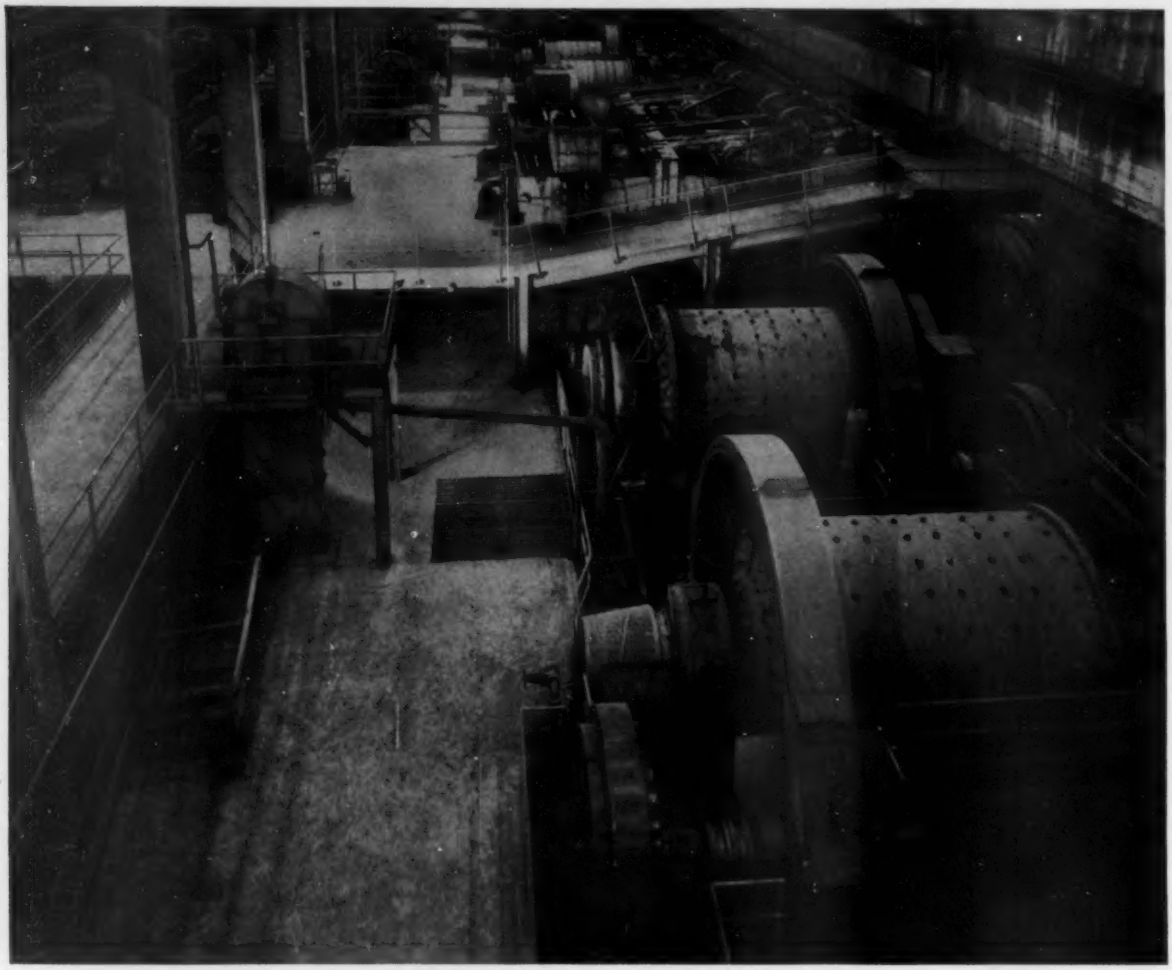


Diagram of LUBRITROL System



Ni-Hard liners save labor, cut maintenance and grinding costs by providing the utmost in tonnage life. Results obtained in our own grinding aisle show economies you can count on for your own mills.

Ni-Hard shell liners wear only .018 lb. per ton grinding more than 3 million tons of nickel ore

This high tonnage life demonstrates the outstanding performance of Ni-Hard* nickel-chromium white iron shell liners in the concentrator shown above.

Only recently, two sets of lifter bar liners were removed from rod mill service in this plant, Inco's Creighton concentrator, which began operating in 1951.

Used in large mill

The Ni-Hard shell liners served in 10'8"x13' mills grinding highly abrasive nickel ores with 3" and 3½" rods. Mills ran at 60% of critical speed. At the discharge, solids in the slurry ran 70%. Total life in the #1 mill was 3,430,000 tons of ore; in #4 mill, 3,266,000 tons. The liners for each mill originally weighed 60,912 lbs.

This example of Ni-Hard shell liner service is a severe one . . . nickel ores are among the toughest. But the record of Ni-Hard liners in such service shows what this material can do for your grinding operations.

Where your abrasion is severe . . . use Ni-Hard liners.

*Registered Trademark

INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N.Y.

Peabody Coal, Curtiss-Wright Form New Company

Complementary research developments have brought Peabody Coal Co. and Curtiss-Wright Corp. to form a joint firm, Peabody-Wright Corp., which will turn out products based on derivatives of bituminous coal. Products of the Peabody carbonization or Mansfield process—coke and low temperature volatile gases—will be used in a Curtiss-Wright process for recovering coal tar from the gases and for producing a new type of paving binder. A plant site search is under way.

May Truck Molten Aluminum 100 Miles to Plant

Aluminum Co. of America and General Motors Corp. reportedly have agreed to have Alcoa deliver molten aluminum in insulated trucks to a GM auto parts plant some 100 miles from the Warrick reduction works. The route—Evansville, Ind., to Bedford, Ind.—would involve travel over open highways. Short hauls of hot metal are being made now in other operations, but never for such a distance and never over public roads. . . . Alcoa's new Warrick plant near Evansville, Ind., is slated to begin operations this June. Capacity of the installation: 150,000 tons per year.

Calumet & Hecla Buys Heavily into Hose Maker

Calumet & Hecla, Inc. has purchased almost all shares of Flexonic Corp., maker of industrial flexible hose products, through an exchange of C & H common stock. Flexonics, which will operate as a subsidiary, had sales of about $19 million last year.

Soviet Diamonds to be Sold by De Beers

All Soviet diamonds slated for export to the West will go through the London offices of the Central Selling Organization of the De Beers group, according to terms of a pact signed by the Diamond Corp. of South Africa and the Soviet Trade Delegation to Great Britain. Details of possible export volume were not revealed.

Light Metal Men Beware . . .

A full pound of scandium—the biggest quantity of the rare metal ever to exist in one place at one time—has been produced by the Union Carbide Metals Co. About as dense as aluminum, but with a melting temperature about two and a half times greater, the scandium will undergo studies by the company for the Air Force.

National Stockpile Virtually Filled

Office of Civil and Defense Mobilization reports basic objectives of the national stockpile are more than 98 pct filled; maximum objectives more than 93 pct filled. Only three materials will be garnered during this fiscal year: chrysotile asbestos, diamond dies, and jewel bearings. . . . Some 19 million lb of cathode nickel—surplus to the Federal stockpile—will be sold for domestic consumption, according to the General Services Administration. The offer of nickel is the first since late 1957.

Aluminum Business Abroad

The international subsidiary of Reynolds Metals Co. is negotiating with the government of Venezuela for construction of a reduction plant that would use imported bauxite and Caroni River hydroelectric power to produce pure metal. . . . Export-Import Bank approved a $13.6 million loan to Hindustan Aluminium Corp. Ltd. (Kaiser Aluminum & Chemical Corp. and the Birla interests of India) for purchase of U. S. equipment and services in building a 20,000-ton reduction plant scheduled for erection in Uttar Pradesh. The site is adjacent to a dam and close to big bauxite deposits. . . . Kaiser is now also actively engaged in forming a new fabricating company in England, jointly financed by an English partner. It has also formed an international aluminum company group called Volta Aluminum Co. which will develop aluminum in Ghana.

Lithium Option Dropped

Dow Chemical Co. of Midland Mich., has dropped its option on some 400 acres of lithium-bearing pegmatite deposit in Maine. Dow had held the tract, on state-owned land, for three years, and had begun an extensive mapping and drilling program. The lithium claim area, in Warren Township, Knox County, is part of a large tract of state institutional land administered by the Maine Mining Bureau.

Additions to Colorado Uranium Mill

Cotter Corp.'s 72-tpd uranium pilot plant at Canon City, Colo., has expanded to a 200-tpd full scale operation during early March. Design and construction of the $1-million addition is by Western-Knapp Engineering Co.

Asarco to Hike Zinc Premiums

Effective April 1, American Smelting & Refining Co. will raise prices of its special high grade and regular high grade zinc by ¼¢ a pound each, to 14¾¢ and 14½¢, respectively. Competitors raised their tags to these levels on January 8.

Silver Use Up Last Year

U. S. silver consumption climbed some 18 pct in 1959, according to refiner-fabricator Handy & Harman. Exports were up, imports down, and the outlook this year is to continued high consumption.

Tantalum Prices Cut

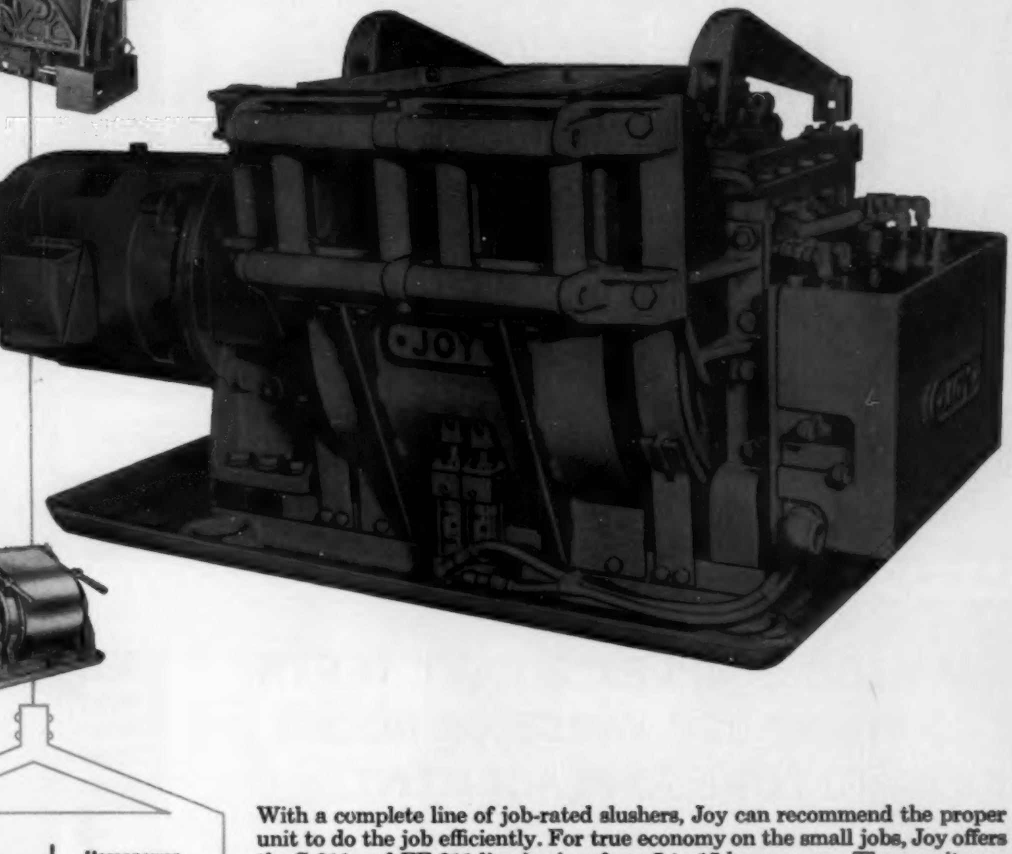
A top producer of tantalum, Fansteel Metallurgical Corp., has announced price reductions of up to 25 pct on tantalum powder, oxide, and carbide. Reason: better efficiency and capacity operation at the Muskogee, Okla., plant.

Mill Facilities Purchased by Humphreys Engineering

Operating assets of Humphreys Gold Corp. have been sold to Humphreys Engineering Co. of Denver. Both firms are subsidiaries of Humphreys Investment Co. Humphreys Engineering, manufacturer of spiral concentrators for ore beneficiation, will operate the mining and concentrating plants involved in the purchase through a mining division.

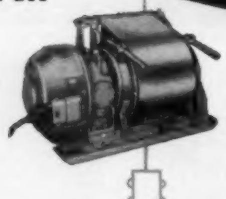
JOY HAS THE RIGHT SLUSHER FOR THE JOB

XT-221



B2F-211

FF-211



Model No.	Horsepower
S-211	5 hp
FF-211 & FF-311	7½, 10, 15 hp
A2F-211 & A2F-311	15, 20, 25 hp
B2F-211 & B2F-311	20, 25, 30, 40 hp
C2F-211A & C2F-311A	50, 60, 75 hp
R-221 & R-222	100, 125 hp
RF-211-212	100, 125 hp
XT-221 & XT-222	150 hp

With a complete line of job-rated slushers, Joy can recommend the proper unit to do the job efficiently. For true economy on the small jobs, Joy offers the S-211 and FF-211 line in sizes from 5 to 15 horsepower. These units are air or electric driven and extremely compact for portability underground.

For medium capacity, Joy builds A and B class slushers from 15 to 40 hp. These two and three drum slushers are designed to handle the bulk of scraping jobs.

Three larger units in the "C" series go up to 75 hp for the heavy-duty jobs where portability is still required. For the largest semi-permanent installations, Joy builds large capacity slushers from 100 to 150 horsepower.

With more than 300 types and sizes of hoists and slushers to choose from, there is not a scraping job that can't be handled most efficiently with a Joy unit. Call in a Joy engineer for the size and type to suit your scraping jobs or write for bulletin 950-7.

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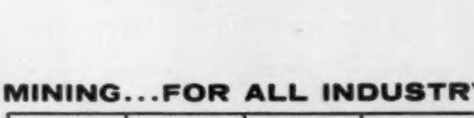

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In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

More proof that . . .

AMSCO HELPS YOU MOVE MORE TONS PER DOLLAR

How AMSCO screen parts and Simplex 2-Part Dipper Teeth are giving users greatly improved service life*

AMSCO CHUTE PLATES LAST 5 YEARS VS. 4 WEEKS FOR PREVIOUS TYPE

In the screen house of this quarry, two Amsco HC-250 abrasion-resistant chute plates are used on each Hi-G discharge screen. 500 tons per hour pass over each plate, during the two-shift, 20-hour operating day.

This installation resulted from a previous test, in which a set of Amsco plates was compared with regular carbon steel plates. The Amsco Chute Plates *lasted about 5 years*, whereas the competitive plates had to be replaced every 4 weeks.

The quarry operator reports that the Amsco plates presently installed are holding up excellently in service. Their exceptionally long life and trouble-free service means big dollar savings—through elimination of costly shutdown time.

AMSCO SIMPLEX 2-PART TEETH DIG 40,000 YARDS OF ROCK BEFORE REPLACEMENT

At the right, you see the type of rugged rock excavation in which this outstanding service record was set. It's part of the Niagara Power Project—Conduit #2 South—being handled by Gull & Defelice Construction Company.

All dippers on the job are equipped with Amsco Simplex 2-Part Reversible Teeth. They operate 16 hours a day, 6 days a week—*handle approximately 40,000 yards of rock*—before tooth replacement is required.

In addition to their exceptionally long wear, the fact that Simplex Teeth *can be replaced in ten minutes with no trouble* is an important advantage to the operators. It all adds up to big savings—in replacement cost and shovel downtime.

*Patent No. 2,904,908

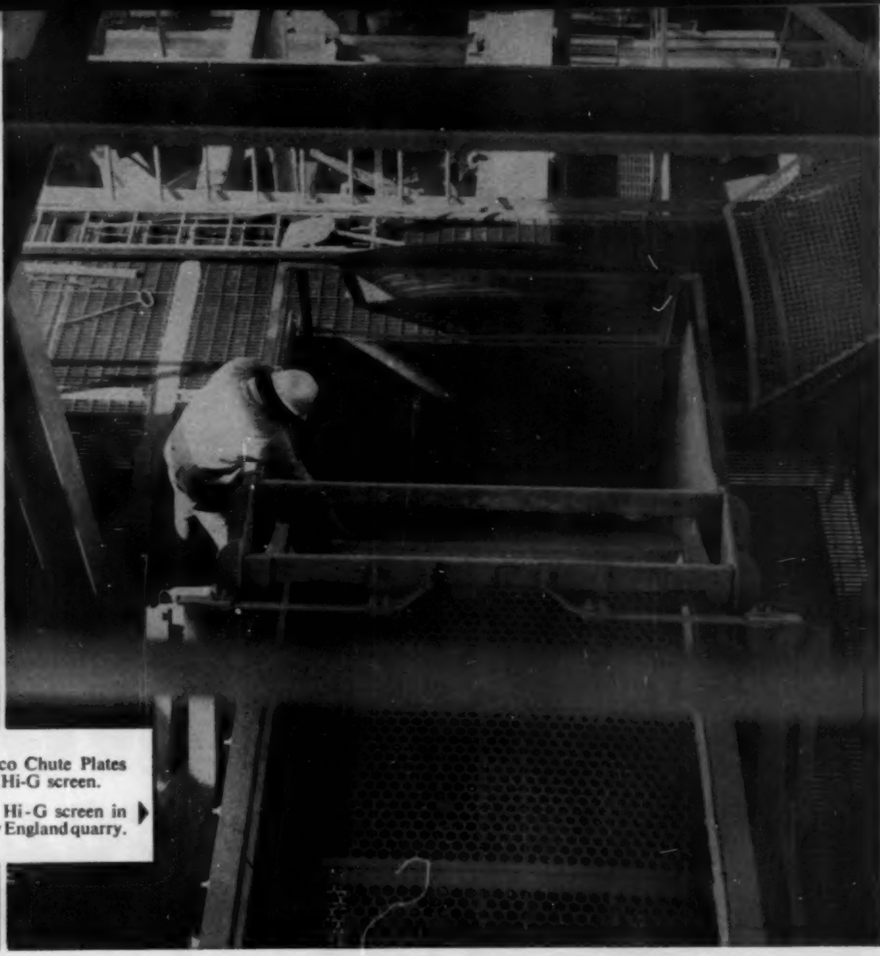
Wherever high impact and abrasion are problems, you'll "move more tons per dollar" with Amsco Dippers, Dipper Teeth and Crusher Parts. See your equipment dealer, or write us direct for technical bulletins.

AMSCO

AMERICAN Brake Shoe COMPANY

American Manganese Steel Division • Chicago Heights, Ill.

Other plants in: Denver • Los Angeles • New Castle, Dela. • Oakland, California • St. Louis
In Canada: Joliette Steel and Manitoba Steel Foundry Divisions



Left: Close-up of Amsco Chute Plates used on each discharge Hi-G screen.

Right: General view of Hi-G screen in screen house of large New England quarry.

Left: General view of excavation at Conduit #2 South. Dipper on Bucyrus Erie 88B shovel is equipped with Amsco 2-Part Reversible Teeth.

Right: Close-up of Amsco 2-Part Reversible Teeth, showing special pin lock which assures positive locking of the reversible tip.

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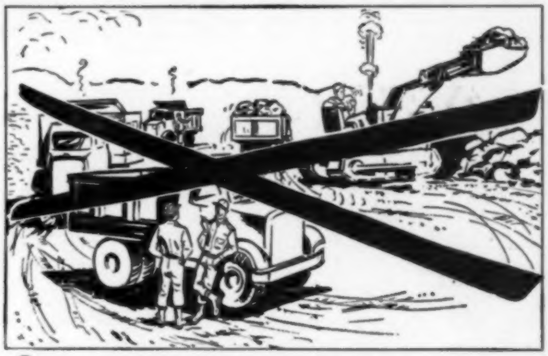

3. NEVER WAITS ON OTHER EQUIPMENT! S-D Transloader saves labor and machine costs wasted in multiple machine operation.

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THIS IS WHY the S-D Transloader is more efficient than conventional equipment and methods of materials handling. But this is not all. The S-D Transloader way is the **lowest possible cost way** because:

1. **LOWEST ORIGINAL COST** for tons handled!
2. **LOWEST MAINTENANCE** due to extremely simple design and high quality of components . . . such as T-1 Steel, Cummings Engines, Clark Axles, Allison Transmissions!
3. **LEAST VENTILATION** required underground due to low horsepower ratio to work-done!
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Our first customer—Cia. de Real del Monte y Pachucha—received our first commercial shipment of AERO Brand Cyanide in January 1917. Four years later, in March 1921, Homestake Mining Company began using AERO Brand Cyanide at their Lead, S.D. sand treatment plant. Both of these outstanding precious metal producers are still numbered among the many mills in every world mining district now using AERO Brand Cyanide.

These long, pleasant and mutually-profitable commercial relationships are based on a service and a product unique in the mining chemical industry.

Through two World Wars and countless local upheavals, AERO Brand Cyanide has been delivered unfailingly the world over. No Cyanamid customer has ever had to curtail or shut down mill operations for lack of AERO Brand Cyanide. Paralleling this unfailing delivery service are the technical services of Cyanamid Field Engineers and the Cyanamid Mining Chemicals Laboratory on beneficiation problems.

Additionally, AERO Brand Cyanide has distinct product advantages. In metallurgical efficiency, based on NaCN equivalent, it equals or exceeds any other grade of cyanide. It is clean and easy to handle. Its inherent protective alkali content usually reduces lime consumption.

Our nearest office will be pleased to quote on your requirements for Cyanide and other Cyanamid Reagents and to bring you the benefits of Cyanamid's research resources.

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About HOMESTAKE metallurgy

Since 1878 Homestake has treated some 85,600,000 tons of ore yielding upwards of 23,000,000 ounces of gold valued at more than $800,000,000 at the current Mint price. Homestake is a brilliant example of continuous study and change of both mining and milling techniques to offset rising costs.

Originally a stamp mill-amalgamation operation, Homestake pioneered the use of cyanidation soon after the turn of the century through the original work of C. W. Merrill. While the complex geologic structure and distribution of the ore was deciphered over the years, metallurgy, too, has been steadily improved.

Homestake recovers 71.5% of values from 4750 t.p.d. by amalgamation after wet grinding through 80 mesh. Sand and slime fractions, about 55% and 45% respectively, are separated by bowl classifiers and cyclones, and treated separately.

Sands with heads averaging 0.115 oz./ton are batch leached with AERO Brand Cyanide solution. Consumption is 0.42 lb/ton NaCN equivalent. Residues average 0.012 oz. and 17% of total head values are recovered in this step. Slimes at 0.070 oz./ton are cyanided in a separate plant with AERO Brand Cyanide solution. Consumption is 0.30 lb/ton NaCN equivalent. Slime residues average 0.006 oz. Values recovered from slimes are 8.5% of total head values in the ore.

Since ore treated assays 0.333 oz. and combined residues average less than 0.010 oz./ton, overall recovery exceeds 97%. Cyanide consumption is 0.35 to 0.40 lb. NaCN equivalent and lime consumption only 2.4 lb. per ton.

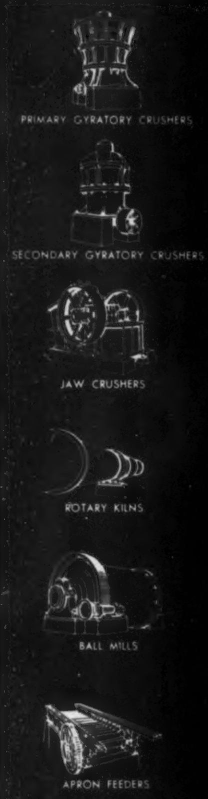
The REAL DEL MONTE story

Worked continuously since the days of Moctezuma, Real del Monte is probably the world's oldest major silver producer. Here the Patio Process was conceived by a Pachuca miner in 1557 and used until supplanted by cyanidation in the early 1900's.

Today Real del Monte treats ore from several deposits; 1400 t.p.d. by cyanidation alone, 1000 t.p.d. by flotation. Ore averaging 253 gm. Ag, 1.26 gm. Au per metric ton and low in base metals goes directly to cyanidation. This ore is ground in an AERO Brand Cyanide solution, maintained at a solution strength of 1.30 kilos NaCN equivalent per metric ton. Overall plant recovery of silver is 83.0% with cyanide consumption of 0.65 kilos NaCN equivalent per metric ton.

Base-metal ore containing precious-metal values is concentrated with Cyanamid flotation reagents. Pb, Zn and Fe concentrates are produced. Tails are cycloned and the 550 t.p.d. underflow is pumped to the cyanide grinding section for treatment with the cyanide feed. Zinc concentrates, cyanided separately, assay 5.0 kilos Ag per metric ton prior to cyanidation; 300 gm. Ag after treatment.

Real del Monte is an excellent example of a very old property that has continuously improved its metallurgy as new ore bodies have been opened and discarded tailings from earlier generations have been reworked with modern beneficiation methods.



sign of engineering leadership

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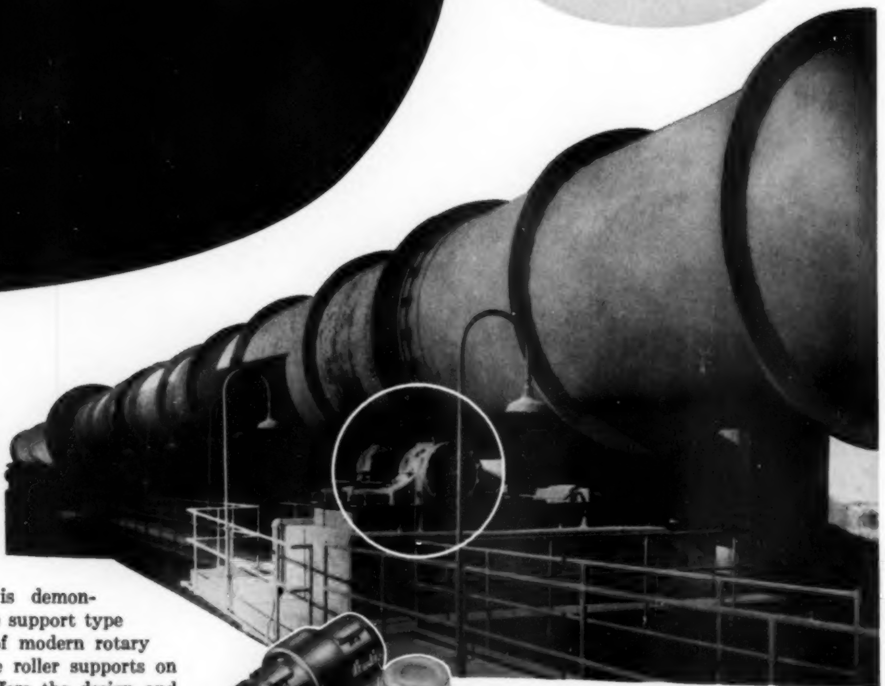

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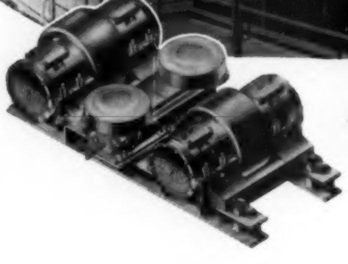

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SME'S PRESIDENT STATES HIS VIEWS

Editor's Note: *It is fitting in this issue of* MINING ENGINEERING, *a portion of which is devoted to the Society's 1960 Membership Brochure, that we publish a statement by the 1960 President of the Society, A. B. Cummins. These are Mr. Cummin's views as a professional engineer and were made as the basis of a press interview when he became Society President at the Annual Meeting, February 14 to 18, in New York. The questions on the mineral industry were posed in advance of the meeting.*

What is the outlook for 1960?

Forecasts predict high industrial activity and prosperity in 1960. (GNP above $500 trillion.) If this is so, we can expect a good year for mining. But the pattern will be spotty and not all branches of mining will fare equally well.

With strikes somewhat in the background for the time being, the iron ore, steel, and the nonferrous metal industries may expect heavy requirements, not only to meet the expected new demands, but also to fill the backlogs resulting from the 1959 work stoppages. The picture for zinc is considered favorable with Tennessee coming more to the fore as the leading producer; copper should be in a good position with possibilities for a revival of production in Michigan and the proving of more substantial reserves in Arizona. Aluminum should come through with a new record.

The production of cement has been forecast to probably drop some 3 to 4 pct from the 1959 level. This is based on a slowdown in the Federal highway program and to an anticipated reduction in home construction due to the squeeze on mortgage money. Production of sand, gravel, and stone may be expected to parallel that of cement. Most other industrial minerals are expected to be in demand equal to or above 1959 levels (abrasives, clays, borax, limestones, gypsum, phosphate rock, potash, salt, sulfur).

The major interest in 1960 is the probability that it will be significant in indicating the trend ahead, and what to expect in the next decade.

What will the decade of the 1960's bring to the mining industry?

Many economists predict for the decade 1960-1969 a boom period of unprecedented advances. Others foresee difficulties and complications. While these may be expected, let us agree that the curve of progress in general will be upward, and possibly to a fantastic degree. Technological advances, population growth, higher living standards, space age requirements, nuclear power developments, are all expected to accelerate the advance.

It should be recognized first that the demand for mineral raw materials moves with general economic trends. Thus the mining industry, per se, will not set the pace, but will follow the (technological, economic, and political) developments of the next decade. This is because the role of the mining industries, in the main, is to supply raw materials (as required by industry).

(Continued on page 224)

Drift by A. B. Cummins

(Continued from page 223)

Aside from industrial economy, and foremost among the factors that will prescribe the role of the mineral industries in the near-term future, is the question of the cold war, the approach to the space age, etc. The emphasis on rockets and missiles will have a tremendous impact on metals. The role of the glamorous metals (beryllium, tungsten, columbium, and others) will be greatly emphasized, because these may be expected to be important, or necessary, for the equipment and devices either for space warfare or for space exploration. On the other hand, if the means for conventional defense or warfare become obsolete (battleships, aircraft carriers, bullets, aircraft, shell casings, etc.) then the requirements, on a large scale, for steel, lead, aluminum, copper, etc., may be expected to diminish to a significant extent.

The mining industry today must become adjusted to meet successfully the changes resulting from the new requirements of the space age. The 1960's will be a period placing great responsibility upon the American mining industry with a challenge to meet an almost certain demand for greater production of most mineral commodities. At the same time there is the requirement of meeting competitive prices of foreign producers. Also the major problem of protecting our future, in reserves and technologies, well beyond the 1960's, indeed into the 21st century and beyond. It seems that tariff protection and import quota restrictions alone cannot be relied upon, in most categories, to meet all of the problems of some phases of our mining industry. It appears more in line to recognize that in most cases we need to sell our products freely among the world-wide consumer countries unrestricted by artificial tariff barriers and currency problems.

It is the opinion of most competent mining authorities that if the American economy is basically sound and if it is in reasonable balance with that of the rest of the world, the American mining industry will be capable of handling the many special and difficult problems which it will have, all in the interests of American and world prosperity and peace.

Since no one can foresee the future in any significant detail, it is perhaps sufficient to point out some aspects of the mineral industries' future that seem at this time important in considering the 1960's:

1) In any economy and under any set of conditions, mineral products and therefore mineral resources will remain of critical importance.

2) Since mineral resources are not created, and once depleted are not renewable, the problems remain of conserving and developing what we have, and devising better ways and means of finding, processing, and using mineral materials.

3) The U.S. mining industry has demonstrated, time and again, that it has the reserve and the stamina to survive the downturns of economic setbacks, and bounce back to meet the requirements of industry and the national economy.

4) It may be expected to continue to have this capacity, provided adequate provision is made nationwide to recognize, provide for, and support the basic requirements of a sound mineral industry.

If we wish to be a little more specific on the status of some of the major mineral commodities during the 1960's, the opinions of many experts in the various fields indicate: **a)** For iron and steel—continued demand. Iron ore resources in adequate supply, strengthened by improved methods for utilization of lower grade ores. **b)** For the next few years, the production capacity of aluminum, nickel, asbestos, etc., will be in excess of demand. **c)** Aluminum and magnesium are considered to have significantly greater importance as materials for construction. **d)** The markets for copper, zinc, and lead and their alloys should expand, and considerable research effort is being expended in the finding and development of new uses for these metals. **e)** Most of the less common metals—tungsten, cobalt, columbium, tantalum, zirconium, and others—are expected to be in greater demand. **f)** As for the basic industrial minerals, the U.S. may anticipate increasing requirements for materials used in construction—cement raw materials, sand, gravel and stone, gypsum, limestone. **g)** Also for the major mineral raw materials for the chemical or process industries—salt, sulfur, clays, also for potash and phosphate. **h)** So far as present information goes, we will continue to be dependent in large part on foreign resources for nickel, manganese, chrome, tin, mica, antimony, tungsten, and some others. Also to considerable extent for copper, iron ore, lead, zinc, thorium, zircon, columbite-tantalate, cobalt, beryl, and some others, because it will remain economic to import some of these mineral raw materials.

In addition to the foregoing, there are listed below four problems which it seems to the writer will be of significant importance in the 1960's:

1) The demand for an adequate supply of properly trained mineral engineers is not being fulfilled. Bachelor degrees in mining engineering conferred in 1958 were 220; estimated in 1959, 205; projected for 1960, 190; thereafter? Currently there are apparently not enough jobs for the full time employment of mining engineers, particularly in exploration work; but this is an unnatural, unhealthy, and unsafe national position and presumably will not continue. There is need to emphasize and bring to the attention of better qualified young men the opportunities and satisfactions in a career of minerals engineering. Efforts in this direction are being taken by AIME, EJC, and other agencies interested in professional engineering as related to the mining industries.

2) In the interests of a sounder and more permanent mining industry, the mining engineering profession has a better public relations job to do. This entails primarily: **a)** Let the public know what mining engineers are doing and emphasize their economic importance. **b)** Let the government know the vital importance of minerals and mining in the international *economic battle* of the 60's. **c)** Bring the story to and develop the interest of students in mineral engineering.

3) It is highly important that there be established a national mineral policy (long term and short term). This involves not only a wise Federal policy on depletion of mineral resources and a policy encouraging the exploration and development of our natural mineral resources, but consideration of all national and international problems in the procurement, distribution, and stockpiling of mineral materials. This policy must consider the specific requirements of the basic and strategic minerals

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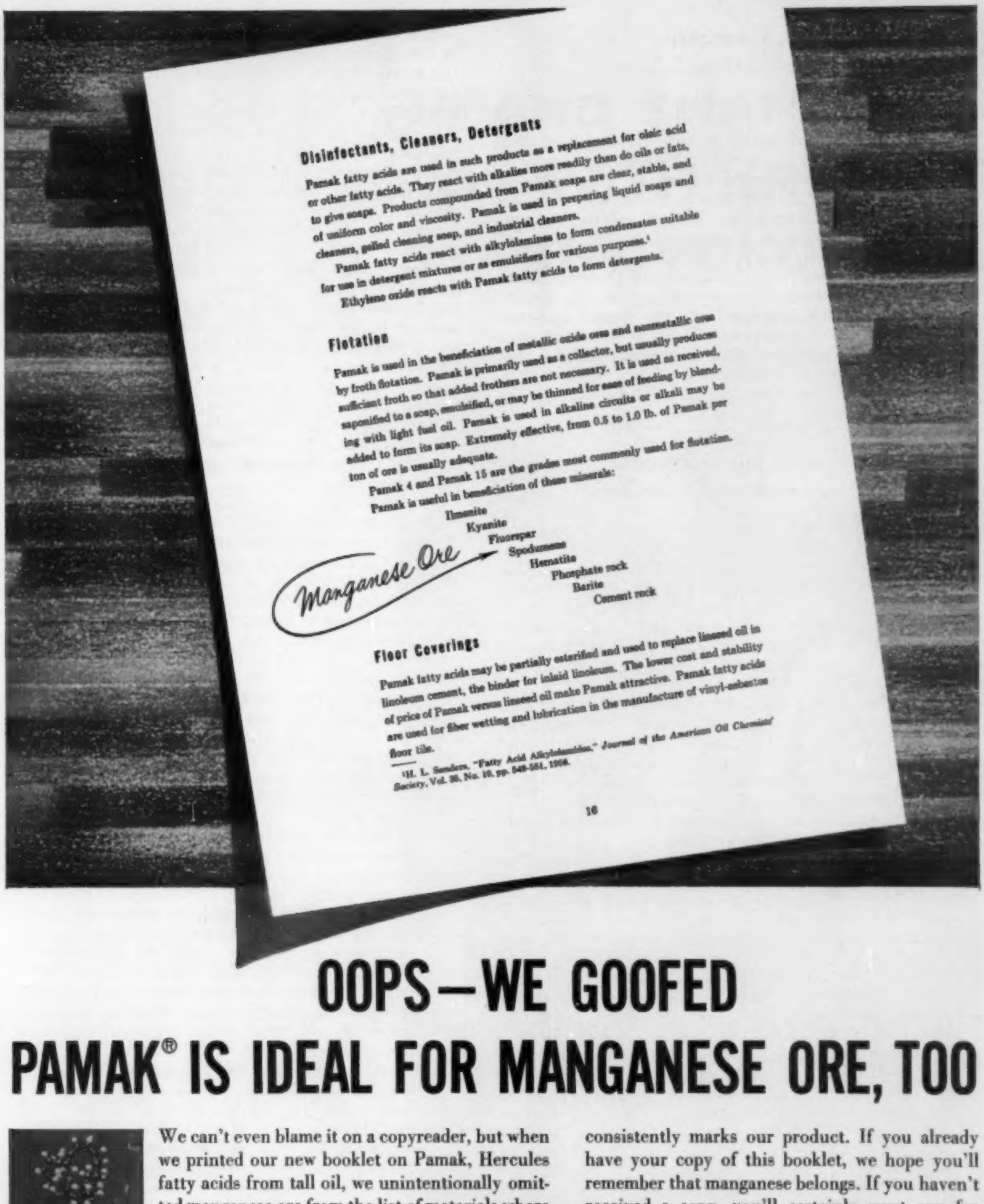

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[1] H. L. Sanders, "Fatty Acid Alkylolamides," *Journal of the American Oil Chemists' Society*, Vol. 35, No. 10, pp. 548-551, 1958.

16

OOPS—WE GOOFED

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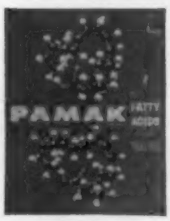

We can't even blame it on a copyreader, but when we printed our new booklet on Pamak, Hercules fatty acids from tall oil, we unintentionally omitted manganese ore from the list of materials where Pamak is exceptionally useful as a flotation agent. But we have *not* omitted our thorough research and technical service, and the high quality that consistently marks our product. If you already have your copy of this booklet, we hope you'll remember that manganese belongs. If you haven't received a copy, you'll certainly want one for your files. A postcard to Hercules will bring you your copy.

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Drift by A. B. Cummins

(Continued from page 224)

and the special cases of lead, zinc, nickel, gold, silver, and others.

4) During the 1960's it may be expected that there will be an increased and significant fusion of the mining and chemical industries. This tendency was manifested in the 1950's. There will be more chemical companies going into the mining business and more mining companies going into chemical. In general, this cross-pollination of interests is inevitable and desirable. Minerals are the raw materials for the inorganic chemical industries. Chemicals and related products are the logical end-uses for many of the materials which are extracted from the earth by mining. The point to emphasize is that this combination of interests is of importance to operators, investors, the general public, and the national welfare.

How will Russian mineral production affect United States and world economy?

Currently Russia is reported to be producing about 16 pct (in value) of the world's total in mineral products (U.S. about 30 pct). The Sino-Soviet communist bloc of nations is considered to be virtually self-sufficient in minerals. In addition, the Soviet Union itself is exporting a variety of mineral products in increasing quantities, and has now become a significant competitor in some international markets. Thus, the Soviet has come from a position of many shortages to one of moderate to substantial surpluses in many mineral commodities, some of which are being sold in free world markets. In this connection, it should be recognized that the framework of the Communist Council for Mutual Economic Aid requires rapid expansion of Soviet mineral production, without regard to immediate economic soundness of this production.

Regarding exports of minerals from Russia, in 1958 it supplied the major share of its European satellites' iron ore requirements, together with some exports elsewhere (Austria). There were also exports of manganese ore, chrome, zinc, asbestos, alumina, apatite concentrates, and potash. There were, however, imports in tungsten, molybdenum, bismuth, vanadium, uranium, and some nonferrous concentrates.

In coal, Russia produced in 1958 529 million tons, as compared with 405 million in the U.S. (U.S. all time high 636 million tons in 1947.)

Apparently Russia is unifying a plan to use to her fullest possible advantage her natural energy fuels, and this accounts for the rapid development of her coal industry (in balance with her use of petroleum and natural gas resources). In this respect, the U.S. seems to lack at present an equivalent national policy toward utilization of energy fuels in the most beneficial long term interests.

Without any attempt to itemize or specify various Soviet activities in the sphere of mineral production, it may be generalized that while Russia is still well behind the U.S. in total production of most mineral products and still further behind in the exploration of such minerals world-wide, the ratio of increase over the U.S. is significant each year and may be expected to be more so in the 1960's and thereafter.

The efforts on the part of the Soviet government in this respect is apparent. Thus, it is reported that the Soviet Union is now employing about 40,000 geologists in the search for or study of mineral resources as compared with a total of about one half this number in all U.S. government, industry, and college employment.

The number and quality of current Russian technical papers on various aspects of mining and mineral technology is impressive. Of still greater significance is the surprising number of Russian publications in the basic sciences pertaining to the mineral industries (mineralogy, geophysics, geochemistry, etc.) The number of students being trained in Russia in mining engineering and in the earth sciences appears to be well ahead of those of the U.S. and perhaps above that of the combined free world nations. Thus, it appears that Russia's national mineral policy is tied directly with its avowed policy of world domination—also that the Soviet fully recognizes the importance of mineral resources and production capacity of mineral products, in the economy of any nation striving for world dominance.

Now there is no apparent way we can stop the Russian approach to parity with the U.S. production of mineral raw materials and finished mineral products. But a national standstill or retrogression in our mineral industries could accelerate the rate of approach by Russia. Equally apparent is the fact that deceleration of relative Russian importance can result from American aggressiveness and progress.

This is not confined to the immediate future, nor for the next ten years. It concerns the longer term future wherein the development and conservation of reserves, depletion of mineral resources in accord with an economical and technically sound plan, and the most effective use of minerals (with consideration of recovery and re-use of mineral values) are all given due consideration.

There is another matter of concern in the Russian mineral industry picture. This is the production and exportation by Russia of mining and mineral processing equipment and machinery. There is an important world-wide market in this field. It seems doubtful if much Russian mining equipment could be sold in the near future in the U.S. but perhaps it could be in foreign markets which are important to the U.S. equipment manufacturers. It seems doubtful if exported Russian equipment at this time can compete with U.S. equipment on a quality and performance basis, but what about comparative prices and what may we expect in future?

In summary, we must recognize that Russia has become and will continue to become an increasingly important factor in the world-wide economy of minerals. There is no need for undue alarm about this situation. The U.S. and the free world have great mineral resources, which if wisely used and conserved, will maintain our position of self-sufficiency or domination. To achieve this position, however, calls for immediate and wise action by the American mining industry, the government, and the public. It is a challenge to the mining industry and to the legislatures of our country to handle its affairs, short term and long term, so that our mineral resources are best utilized in the broad interests of national and international welfare. That this can be done is positively certain, and it is an obligation of the mining engineering profession to see that it is done.—*A. B. Cummins*

UPGRADING AND SHARP CLASSIFICATION WITH KREBS INTEGRAL 2-STAGE CYCLONES*

*The three-products feature of this cyclone design creates profits by upgrading ores of iron, chrome, manganese, copper, gold, glass-sand, alumina, and other industrial minerals. The Krebs integral two-stage cyclones are a standard method used ahead of spirals for upgrading in iron washing plants—see photo.

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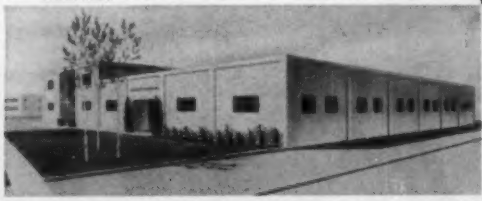

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Designed for action . . . with plenty of power for both machine drive *and* bucket hydraulics. Choose from 2 great new engines . . . the compact, 4-cylinder Cat D330 Diesel Engine, turbocharged for maximum efficiency . . . or the 6-cylinder gasoline engine. Both are 105* HP units. Both are made to the same rigid standards. Whatever the requirements of your operation, there's a No. 944 powered to meet your needs.

Tailored to this power is a torque converter and power shift transmission, providing smooth, instant, finger-tip shifting. A full range of work and travel speeds is available. Travel Range gives 2-wheel drive for roading . . . Work Range automatically puts power to all 4 wheels. Reverse speeds are 25% faster than forward speeds . . . important in reducing cycle time.

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The No. 944 brake system provides safer, more precise control. The *left* brake neutralizes the transmission as it stops the machine. This gives superior loading action in extra-tough material. The *right* brake leaves the transmission engaged for full control when creeping, working on steep slopes or roading downhill.

Designed for economy . . . sound engineering, modern design, service accessibility, quality construction . . . all add up to a new kind of stability. This is the kind of stability that minimizes maintenance and operating cost . . . keeps the machine working at top production . . . keeps it working profitably.

Visit your Caterpillar Dealer the week of March 14. See for yourself how the No. 944 Traxcavator pays off on your loader jobs.

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**For comparative purposes, the maximum rating of the Caterpillar D330 Diesel Engine used in the No. 944 is 135 horsepower.*

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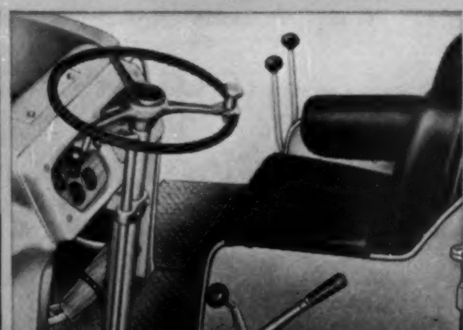
A GREAT NEW PRODUCT IN THE CATERPILLAR TRADITION

Wide steps make it safe to get in and out of the No. 944 from either side. No need to climb over tires. Lift arms do not obstruct operator.

The forward-reverse lever is located on the steering column. Both bucket control levers have kick-out devices: lift control releases at dumping height, tilt control positions the bucket for digging.

Fenders provide a handy platform for checking the engine, and they protect the operator from mud and rocks.



BRIEF SPECIFICATIONS

Bucket capacity	2 cu. yd.
Bucket reach (@ 7 ft. dump height)	50¾ in.
Over-all width (bucket)	93½ in.
Wheelbase	88 in.
Speeds, forward (4)	0-24 MPH
reverse (4)	0-[illegible]0 MPH
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Shipping weight — with gasoline engine	20,440 lb.

There's a wealth of LOADER KNOW-HOW behind the No. 944.
It comes from the builders of the best accepted track-type tractor-shovels in the field.

The No. 944 is offered with a full line of versatile attachments and accessories... forks, cab (shown here), special buckets ...and the exclusive side dump bucket.

Every feature of the No. 944 is designed for efficient work. Ample horsepower... finger-tip shifting... smooth, fast bucket action... outstanding operator comfort and safety. The result... a bold new wheel loader... the Cat No. 944 Traxcavator.

YOU AND SME MEMBERSHIP

Starting on the facing page is a 12-page section giving a picture of SME and its component parts—and what they mean to a prospective member.

The section is being included in this issue of MINING ENGINEERING *for two reasons: 1) Obviously the letter on the facing page is not intended for you if you are already an SME member, but rather for you to use as one man on SME's 12,000-plus membership committee. 2) As we put together this annual section, the basis for SME's Prospective-Member Brochure, we again realized that almost all of the material would be of interest to members who, far too seldom, are given an overall picture of the Society to which they belong. A once-a-year refresher is good for all of us who belong to—and believe in—SME.*

Again, as in 1959, this section will be reprinted and available for use as part of SME's 1960 membership campaign. We know the membership campaign has your moral support—but if SME is to grow stronger, we need the efforts of every member on a man-to-man basis. Your Society's continued strength—and future —is your individual responsibility.

A MESSAGE FROM THE 1960 SME PRESIDENT

JOHNS-MANVILLE
PRODUCTS CORPORATION
RESEARCH CENTER
MANVILLE, NEW JERSEY • TELEPHONE: RANDOLPH 5-5000

To Engineers of the Mining Industry:

All members of the Society of Mining Engineers of AIME join me in extending to you an earnest invitation to investigate the advantages of membership in our Society, and then to apply for membership.

SME is America's professional organization for all qualified men associated with the mineral industries. It is an obligation, as well as a privilege, for all engineers to support their major professional society, by membership in same, and by participation in its meetings and other activities.

Mining men, by and large, are fraternally minded, willing to share their knowledge in technical matters and happy in social relations with their colleagues.

SME is the means by which such beneficial relationships are fostered. Its sole function is to serve the varied interests of the mining engineering fraternity, and in so doing, meet our responsibility for the winning and economic use of our mineral resources.

We believe that SME merits the support of every qualified mineral industry engineer, and in turn feel that the Society has much to offer for the professional advancement and personal satisfaction of each member.

My personal message to you is to study carefully the information transmitted herewith. We trust that we may have your favorable response.

Cordially yours,

A. B. Cummins

A. B. Cummins
1960 President
Society of Mining Engineers of AIME

WHAT IS SME?

The Society of Mining Engineers (SME) is a constituent Society of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME). The Mining Engineers are the oldest professional group and, until recently, have been the largest of the three Societies of AIME (the others are The Metallurgical Society and the Society of Petroleum Engineers).

As the result of a meeting in Wilkes-Barre, Pa., in April 1871, the American Institute of Mining Engineers, as it was then called, was founded. Objectives of this first meeting were "First, the more economical production of the useful minerals and metals. Second, the greater safety and welfare of those employed in these industries."

Today the purpose of AIME remains much the same "To promote the arts and sciences connected with the economic production of the useful minerals and metals, and the welfare of those employed in these industries by all lawful means; to hold meetings for social intercourse and the reading and discussion of professional papers, and to circulate by means of publications among its members the information thus obtained, and to establish and maintain a place for meeting of its members, and a hall for the reading of papers and delivery of addresses, and a library of books relating to subjects cognate to the sciences and arts of mining and metallurgy."

That original meeting in April 1871 was attended by a group of 21 men. When formal membership rolls were published, 71 names were listed. From that preliminary membership list, the Institute, in 89 years, has grown in size to over 35,000 members, including students.

Although both "mining" and "metallurgy" were terms used in the organizational call and other announcements, the word "metallurgical" was not included in the Institute name until 1919. In 1956 the word "petroleum" was added, giving full titular recognition to the three full-fledged branches of the minerals industry—Mining, Metallurgy, and Petroleum.

Perhaps the most concrete testament to AIME achievements is the *Transactions*—volumes of technical literature published. No. 1 is dated 1871. Of particular interest to miners is No. 214, publication data: 1960.

Prior to 1956 three groups within AIME were Branches of the Institute under the direction of the Board of Directors of AIME. In 1956 when the three Branches became constituent Societies of AIME each was organized with its own President and Board of Directors. Decisions which relate to all three remain in the hands of the AIME Board. The Society of Mining Engineers prior to 1956 was known as the Mining Branch of AIME. Under the reorganization plan of the Institute, the Society came into being at New Orleans in February 1957. Today over 14,000 names are listed on the membership rolls of the Society. To learn more about SME, the men who run it, how it operates, and what it offers its members, read the following 11 pages.

WHO RUNS SME?

President

A. B. CUMMINS

Arthur B. Cummins was installed as President of the Society of Mining Engineers for 1960 at the AIME Annual Meeting in New York. He is manager, Central Chemical and Physical Research Dept. of the Johns-Manville Research Center, Manville, N. J.

Born in 1895 in Los Angeles, Dr. Cummins graduated from the University of Chicago in 1920 with a B.S. and earned his doctorate at the University of California in 1920. He joined the Celite Co. (now part of Johns-Manville) and became a development engineer, research engineer, manager of Celite research, manager of basic research, and finally in 1956 manager of the department he now heads.

Dr. Cummins has been an active member of AIME since 1936, serving on many committees and acting as eastern vice chairman of IndMD, chairman in 1951, and member of the AIME Board of Directors. In addition to his AIME affiliation, he belongs to the Mineralogical Soc. of America, the Mineralogical Soc. (London), The New Jersey Mineralogical Soc. which he helped organize in 1934, and the New York Mineralogical Soc. He served on the Western Governors' Mineral Policy Conference Committee on Research in 1955 and on the Western Governors' Mining Advisory Council as technical advisor from 1955 to 1956.

Dr. Cummins is recognized internationally as an authority in mining asbestos, mineralogy, and filtration; holds 17 patents; and he has written many technical papers in his fields of specialty.

Other Officers (Past-President, President-Elect, Treasurer) and Regional Vice Presidents (Eastern, Central Area, Western)

J. C. GRAY

J. W. WOOMER

C. E. LAWALL

D. W. SCOTT

H. C. WEED

N. ARBITER

James C. Gray, SME President-Elect, was born in Elco, Pa., in 1904 and graduated from Pennsylvania State University in 1925 with a B.S. in mining engineering. He worked for Hudson Coal Co. for 12 years and in 1937 became superintendent of the Wylam Mine for U. S. Steel Corp. Mr. Gray became, in 1950, manager of the Tennesee Coal & Iron Div.'s manufacturing operations. Made vice president, Coal Div. of U. S. Steel, Pittsburgh, in 1954, he became, in 1958, administrative vice president, raw materials. At present he is one of SME's representatives on the AIME Board.

J. W. Woomer, Past-President of SME, is well known in mining and coal circles, and head of his own consulting firm, J. W. Woomer & Assoc. A native of Philipsburg, Pa., he received a B.S. from Pennsylvania State University in 1925 and an E.M. in 1931. During his summer vacations he worked in the central Pennsylvania coal fields and later in Maryland. Mr. Woomer's earliest professional association was with the Pittsburgh Coal Co. and he was later active in the Ohio fields during a period with Hanna Coal Co. He formed his consulting firm in 1940.

Charles E. Lawall is Eastern Regional Vice President and is serving a three-year term until 1961. He is vice president of the Chesapeake & Ohio Railway Co. A graduate of Lehigh University with E.M., M.S., and honorary LL.D. degrees, he was born in Catasauqua, Pa., in 1891. In 1938 he was made acting president of West Virginia University. Almost immediately he became president of the University, a position he held until 1945 when he became engineer of coal properties for the Chesapeake & Ohio Railway Co.

Donald W. Scott is Vice President, Central Regional Area. He is general manager of Continental Sales & Equipment Co. A native of Minnesota, he received an E.M. degree from the University of Minnesota and a master's degree in metallurgical engineering from the University of Alabama. His career started in 1937 at Bingham Canyon, Utah, and he did research work on industrial minerals at the Southern Experiment Station of the U. S. Bureau of Mines at Tuscaloosa, Ala. He also spent 12 years at Battelle Memorial Inst. directing research.

H. C. Weed, Western Regional Vice President, is a native of Michigan and a graduate of Michigan College of Mines. After a short stint as efficiency engineer and miner for Calumet & Hecla Mining Co., he joined United Verde Copper Co. in Jerome, Ariz. Since 1937, he has been associated with Inspiration Consolidated Copper Co. in Inspiration, Ariz., beginning his career there as shift boss, eventually becoming assistant general manager, and then general manager. Recently Mr. Weed was elected vice president and director of the company.

Nathaniel Arbiter is Society Treasurer as well as Director. Professor of mining engineering at Columbia University, he received his degree from Columbia in 1935. He served with the Battelle Memorial Inst. and Phelps Dodge Corp. in Arizona and New York before accepting the post at his alma mater. He has been active in MBD since its founding; has been chairman of the ECPD New York Section and the AIME Technical Publications Committee; and is one of the AIME representatives on the Engineering Societies Monographs Committee.

Secretary

JOHN C. FOX
SME
29 W. 39th St.
New York 18, N.Y.

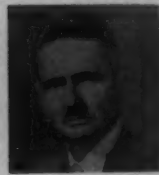
John C. Fox, SME Secretary, graduated from Columbia University School of Mines and held a variety of jobs in the mineral industry ranging from mine laborer to assistant manager of the mining division of a large mining company. He also spent four years teaching at Columbia and has had extensive editorial experience through work for *Canadian Mining Journal*, *American Metal Market*, *Engineering and Mining Journal*, and as editor of *Mining Congress Journal* for five years. He has traveled extensively in his mining positions in the U. S., Canada, and Latin America.

THE SME DIRECTORS


J. G. BROUGHTON


S. S. COLE


C. T. HAYDEN


S. F. KELLY


E. KIPP

John G. Broughton is state geologist, Geological Survey of New York, Albany. Born in 1914 in Rome, N. Y., Dr. Broughton received A.B. and M.S. degrees from the University of Rochester, and a Ph.D. from Johns Hopkins University in 1940. For three years he worked for the U.S. Geological Survey. Dr. Broughton has been an instructor at Syracuse University and assistant state geologist as well as acting state geologist.

Sanford S. Cole is assistant manager of research at National Lead Co. A graduate of Alfred University where he obtained B.S. and M.A. degrees, Dr. Cole now serves as a trustee for the University. He earned a doctorate in ceramics from Pennsylvania State College in 1934. It was in the same year that he joined National Lead in the Titanium Div. Dr. Cole was research supervisor from 1945 to 1948 at National Lead.

Brower Dellinger is assistant manager, Tahawus, N. Y., operation, Titanium Div., National Lead Co. Inc. A graduate of Stanford University with a degree in mining in 1936, he began his career with Newmont Mining Co. in Grass Valley, Calif. After the war he returned as general superintendent, then becoming assistant manager of all Newmont's gold properties. He joined National Lead in 1954.

Carl T. Hayden is vice president and general manager of Sahara Coal Co. Inc., Chicago. Born in Platteville, Wis., in 1893, he graduated from Wisconsin School of Mines. His early professional experience was gained in the nonferrous industry, particularly zinc, during his service with Wisconsin Zinc Co. In 1920 he joined Madison Coal Corp. as division engineer and his career in coal has spanned more than 35 years.

Sherwin F. Kelly studied at the University of Kansas, the University of Toronto, the Sorbonne, and Ecole des Mines in Paris, and was a pioneer in the introduction of geophysical techniques in the U. S. and Canada in 1921, in association with the Schlumberger firm of Paris with which he was connected. He is president of two companies: Sherwin F. Kelly Geophysical Services Inc. and Geophysical Explorations Ltd.

Ewald Kipp, who was born in 1899, graduated from the Texas College of Mines and Metallurgy (Texas Western) in 1922 and began work for the El Paso Smelting Works, a subsidiary of American Smelting and Refining Co. He spent three years in Mexico for the Cananea Consolidated Copper Co. In 1936 he worked for the Sullivan Machinery Co. He joined his present employer, Eimco Corp., Salt Lake City, in 1945.

Raymond B. Ladoo, a well known consultant in the industrial minerals field, is a native of Ayer, Mass., and maintains his headquarters in Newton near Boston. A graduate of Harvard University, he began his professional career with two Virginia companies, Low Moor Iron Co. and John B. Guernsey & Co. Inc. His varied activities particularly qualify Mr. Ladoo for his present consulting position.

H. E. Mauck is general superintendent of Olga Coal Co., Coalwood, W. Va. Born in Danville, Ill. in 1914, he received his first mining experience in his father's coal mine where he worked for three years. He then attended the University of Illinois and later Pennsylvania State University from which he graduated in 1939. Upon graduation he was associated with Pittsburgh Coal Co. before joining Olga Coal Co. in 1948.

Charles F. Park, Jr., is dean of the School of Mineral Science at Stanford University where he had gone as professor of geology in 1946. He received a B.S. degree in mining engineering from the New Mexico School of Mines in 1926, an M.S. from the University of Arizona in 1929, and a Ph.D. in geology from the University of Minnesota in 1931. He then joined the U.S. Geological Survey, remaining until 1946.

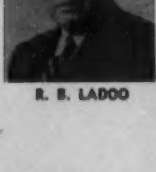
R. D. Satterly was born in Michigan and attended Michigan College of Mining and Technology, receiving B.S. and E.M. degrees. He was employed by Inland Steel Co. after graduation, successively as engineer, chief engineer, mine superintendent, and general manager of ore mines. He is now vice president and general manager of Caland Ore Co. Ltd., a subsidiary, and a director of several organizations.

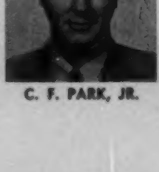
W. W. Simmons is chief geologist for Miami Copper Co., Miami, Ariz. A native of Birmingham, he graduated from Birmingham-Southern College with a B.S. in 1933. Before entering the University of Arizona where he earned an M.S. in 1938, Mr. Simmons worked for Hog Mountain Gold Mining and Milling Co. and for USGS. In 1938 he joined Tennessee Copper Co., and in 1953 he went to Miami Copper.

E. M. Spokes is professor of mining engineering at the University of Kentucky. A native of Philadelphia, he studied at Lafayette College, the University of Kentucky, and received a Ph.D. from Pennsylvania State University. He worked for Bethlehem Steel Co. and National Lead Co. as mining engineer, foreman, and assistant superintendent. He had various teaching assignments while in the U.S. Army.

William B. Stephenson is vice president, Allen-Sherman-Hoff Pump Co., Wynnewood, Pa. Mr. Stephenson received a B.S. in mechanical engineering from Pennsylvania State University in 1933. He started his career as sales engineer for Cities Service Co., Pittsburgh, and after four years joined Jerguson Gage and Valve Co., Boston. Mr. Stephenson became associated with his present company in 1938.

Norman L. Weiss is milling engineer for American Smelting and Refining Co., Salt Lake City. A graduate of Massachusetts Institute of Technology with a B.S. and engineer of mines in 1923, Mr. Weiss was born in Boston in 1902. He did graduate work and research at Pennsylvania State College. Mr. Weiss began his years with Asarco in 1924 in El Paso, Texas, as a metallurgist dealing with ore dressing problems.


R. B. LADOO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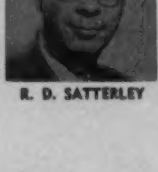
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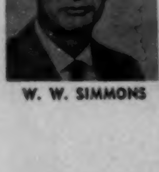
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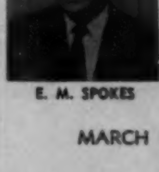
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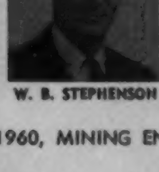
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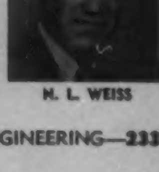
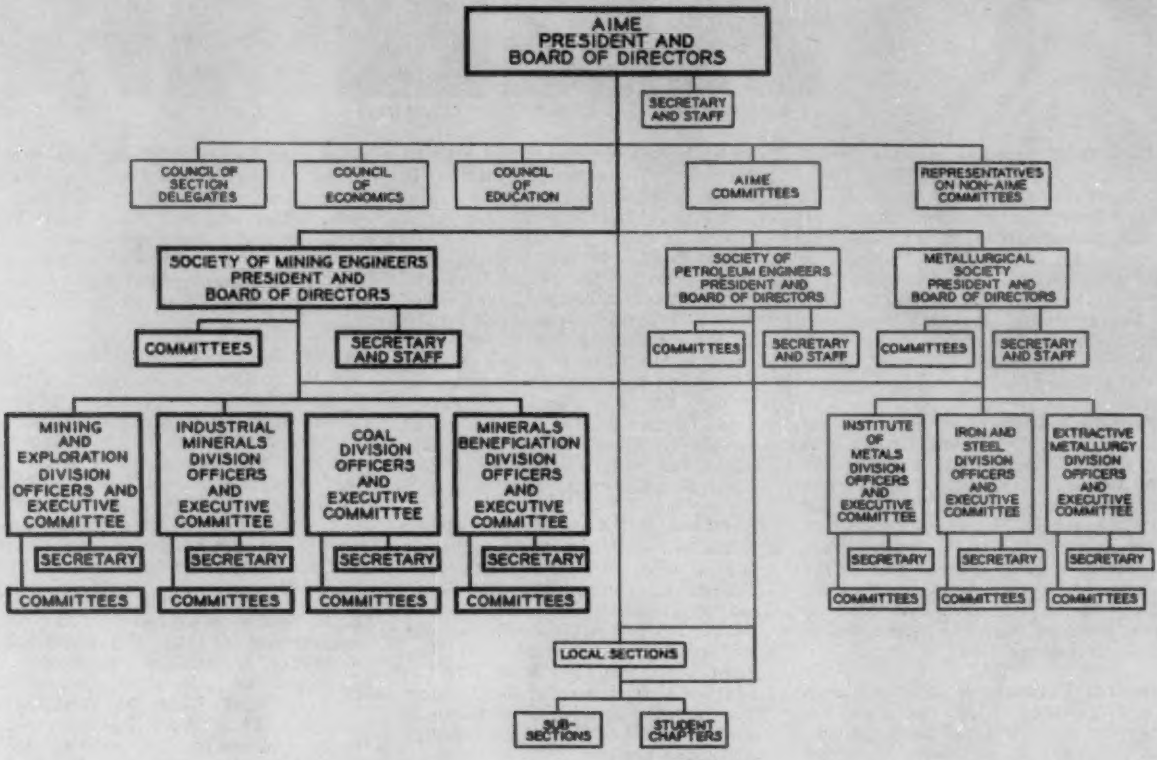

N. L. WEISS

HOW DOES SME OPERATE?



The Society in AIME

The Society of Mining Engineers (SME) is one of three constituent Societies of AIME, dedicated to carrying out the aims of the Institute in the field of activity relating to the Society. The Institute as a whole, and each of the Societies, is built on a broad foundation of active Local Sections.

The Society Itself

The Society of Mining Engineers is divided into four Divisions, all operating under the direction of the Officers and Board of Directors. SME is dedicated to the mutual exchange of knowledge and ideas leading to a higher technical and professional standing for its members. One of the principal ways in which this is done is through cooperation in an all-AIME Annual Meeting as well as sponsorship of Local Section, regional and Divisional meetings throughout the year. For example, there is a joint fall meeting with one of the AIME Local Sections which is devoted to topics of interest to those in the local industry. There are, from time to time, meetings of interest to those engaged in minerals beneficiation, coal, and industrial minerals. The mining and exploration group within SME cooperates alone or jointly with other Divisions in Local Section, state association, or university meetings and regional meetings of the Institute.

SME Committees

The committees of SME coordinate the efforts of the Divisions to produce the greatest amount of service to members of the Society. As can be seen in the organization chart above, there are committees devoted to maintaining and enhancing the quality of the Society publications, its programming, and its participation in such activities as education and economics information.

Local Sections

The Local Sections of AIME are the focal points of professionalism and the foundations upon which are built the activities of each of the Societies and the Institute as a whole. Participation in the affairs of these Local Sections promotes personal contacts and down-to-earth discussions of common problems, aims, methods and achievements The face-to-face exchanges of information and ideas promote a climate of mutual endeavor on a personal level. This type of exchange is an essential ingredient of professionalism and growth of the individual. The starting point for such achievement is attendance at the Local Section meetings.

Divisions

In order that SME perform its functions to the fullest extent as a professional Society, based on individualism, it is divided into four Divisions to truly represent the technical interests of its members.

The Mining & Exploration Division includes members interested in underground and open pit metal mining, geology, geophysics, and geochemistry.

The Coal Division includes all members interested in the finding, mining, cleaning, and utilization of bituminous coal and anthracite.

The Minerals Beneficiation Division deals with the problems of making marketable products out of run-of-mine ore.

The Industrial Minerals Division is devoted to the industrial minerals field and functions through nine commodity committees.

There is some degree of overlapping of interests among the Divisions. This aids the unity of the Society and a member is free to attend meetings of any Division. Each Division is fully represented on the Society's Board of Directors. The officers of SME have been active in the Division which represents their professional interests. On the following four pages each of the Divisions will *speak for itself.*

H. O. ZIMMERMAN, DIVISION CHAIRMAN

Organizations made up of foremost engineers and other professional people are very important in today's fast-moving industrial and commercial world. The tremendously rapid progress in technical and scientific developments during recent years has made such organizations even more important today than in former years.

Progress and developments of this kind have taken place in the coal industry. Due to the need stressed by the extremely competitive situation within coal commerce specifically and the competition coal has to meet from other fuels generally, this progress and development may have been at an even more rapid pace in that industry than in industry generally.

Professional groups add a stabilizing, coordinating medium whereby developments, progress, and new ideas, as well as problems, can be frankly studied, compared, and discussed. They provide an effective opportunity for collaboration among members from widely scattered locations in the advancement of all types of technical and scientific undertakings.

More important yet, through meetings and the distribution of information-bearing issues, such as magazines, bulletins, and others, full enlightenment of members is maintained on all such undertakings, both those in the process of development and those which have been carried through to fulfillment and put to practical use.

Technical meetings sponsored by organizations of professional men afford an opportunity through the presentation of prepared papers and talks to familiarize members regarding new and adopted ideas and methods, at the same time affording an opportunity for discussion.

Often, from such enlightenment, a member will find for himself, or the concern with which he is connected, solution to a particular problem or relief from circumstances that have been difficult and a source of economic loss. Such information may also lead to the adoption of methods that are an improvement over those being utilized, the result again being economic improvement.

The Society of Mining Engineers stands recognized as a top ethical group as compared to strictly trade groups. It offers to members all the advantages herein cited, as well as many others.

To those individuals closely associated with the coal industry, membership in the Coal Division of SME extends all of those same advantages as specifically related to that industry.

The Coal Division was organized to promote closer association of professional men connected with the coal industry, the exchange of ideas and experiences, development of new ideas and methods, and dissemination of information of common interest to the industry, the purpose of all this being to improve operations and practices so that economic conditions can, in turn, be improved.

The Division operates through an organization consisting of Chairman, Secretary, Executive Committee, and a number of other committees, each dealing with some pertinent and important phase of the activities and objectives of the Division. All of the men holding posts in this organization are devoted, capable individuals, highly interested in the affairs of the Division and their industry.

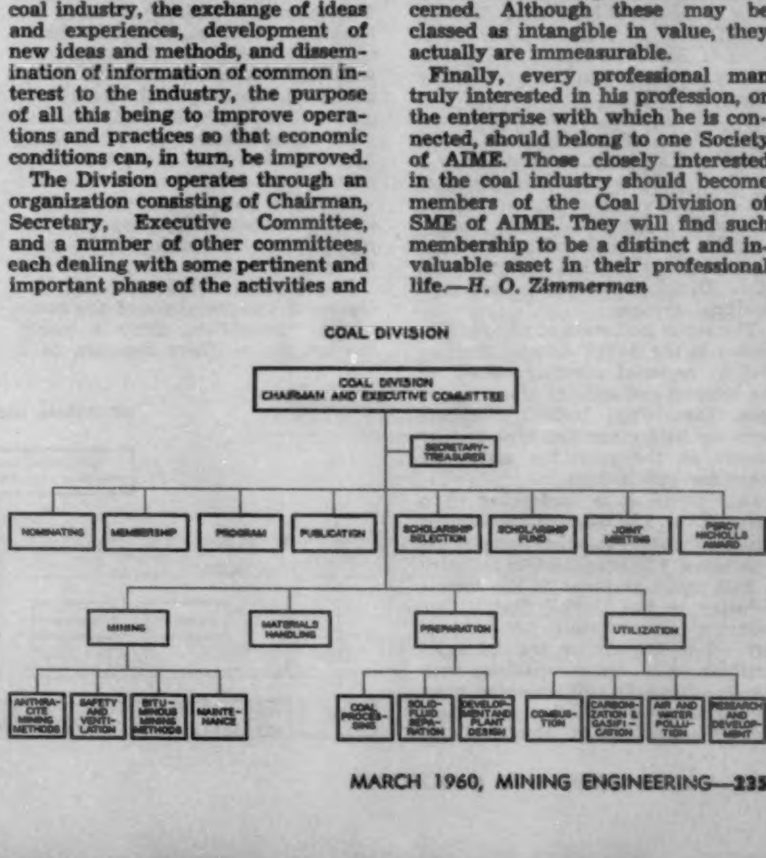
To the individual, membership means that the facilities and services of the Division become available to him for utilization as may best serve him. It means participation in the benefits and advantages enumerated in this article.

It may appear questionable to qualified members, either young or old, as to whether the need for membership can be evaluated in tangible worth. Even though tangible worth of membership may not be obvious or readily evaluated, it is such that no professional man can afford to remain separated from the organization and not participate in its affairs.

Furthermore, there are intangible advantages in membership such as prestige, close association with other outstanding individuals in the same profession, and the satisfaction of participation in the extremely important and worthwhile matters with which the organization is concerned. Although these may be classed as intangible in value, they actually are immeasurable.

Finally, every professional man truly interested in his profession, or the enterprise with which he is connected, should belong to one Society of AIME. Those closely interested in the coal industry should become members of the Coal Division of SME of AIME. They will find such membership to be a distinct and invaluable asset in their professional life.—*H. O. Zimmerman*

COAL DIVISION



INDUSTRIAL MINERALS NEWSLETTER

R. H. FEIERABEND, Division Chairman

From abrasives to zircon—from search and discovery to production and marketing—leave out metals and fuels and you have the depth and breadth of the minerals industry covered by the Industrial Minerals Division. One need only to glance down the list of our Commodity Committees (see below) to envision our dimensions.

We celebrate our 25th anniversary as a Division this month. Though IndMD is one of the smaller Divisions of SME, we take pride in our ability to serve and attract many times our primary membership. We find, for example, some who cover the spectrum of activity from search to sales of a particular commodity—we find some whose main interests are in the geology or the processing of a wide range of minerals. Consequently, we have found some of our best meetings are held jointly with other Divisions or with other professional groups.

The scope and scale of our participation in the AIME Annual Meeting and in regional meetings attest to the interest and activity of our members. Invariably, IndMD members come up with many fine high quality papers at the meetings and offer them for publication.

Our Division is something of a paradox in the Society—somewhat undestrandably so—but nonetheless a paradox. The nonmetallics industry is half again as large as the metals industry in the United States. Our industry's growth-rate far exceeds any other branch of the minerals business. And, by comparison with metals during the 1958 recession, nonmetals as a whole had a good year. Yet we are one of the smaller Divisions of SME—and our Division's growth rate is lagging behind the industry.

We are proud of the contributions our industry has made and is making to the welfare and stability of our country and its economy. We are proud of the contributions our members have made to the mineral world—the late Oliver Bowles, Ray Ladoo, Joe Gillson, Sam Dolbear, to name only a few. There are hosts of others—real stalwarts and peers.

IndMD extends a hearty invitation to *all* in the minerals industry—particularly the nonmetallics—to look us over. We extend a special welcome to you who are not AIME members. If you are in the minerals business we know you have something to offer your fellow professionals and we, in turn, to you. Opportunities abound in IndMD. When you look us over we hope you will like what you find and will join us!

Organization

The chairman directs the overall Division activity under the surveillance of the executive committee. The committee makeup includes the chairman, seven regional vice chairmen, nine members (directors), the secretary-treasurer, and the past-chairman. The regional vice chairman will act with the chairman and secretary-treasurer as a *working board* under the executive committee.

Standing committees include nonination, membership, program, and representation on various SME committees.

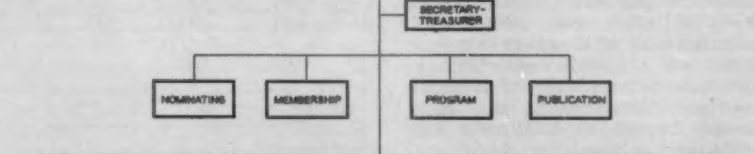
The program chairman and the chairmen and members of the commodity committees carry a heavy burden, for on them depends, to a large degree, the success of Divisional activities at the Annual and regional meetings. Theirs is the job of securing papers, lining up sessions, and all the myriad details that invariably come up and must be decided upon.

Meetings

Each year the Industrial Minerals Division plays a large part in the annual Institute program, with three full days of technical papers and its Divisional luncheon. Then there are regional meetings held, usually in the fall, at various spots around the country. In 1959 it was at picturesque Bedford Springs, Pa. The smaller regional affairs avoid the hub-bub and rush of the Annual Meeting. They go a long way toward cementing the group together and permit a more concentrated effort strictly in the IndMD field.

History: The present Division was born in 1935 when the AIME Board of Directors, at its March 15 meeting that year, formally created "an Industrial Minerals Division (Nonmetallics) in the Institute," to quote from MINING AND METALLURGY, April 1935. Actually the Division was an outgrowth of a nonmetallics committee of AIME which had been active for about a quarter of a century prior to 1935. IndMD was to provide "a needed forum for discussion and a suitable medium for the publication of technical papers of vital interest to the leaders in the nonmetallics industries"—*M & M.* It was in the same year that, under the sponsorship of the Seeley W. Mudd Memorial Fund, preparations were begun for the first edition of *Industrial Minerals and Rocks.* The third edition has just been published—in 1960.

INDUSTRIAL MINERALS DIVISION



mBd'ers digest

MINERALS BENEFICIATION DIVISION

H. R. SPEDDEN, Division Chairman

Membership in the Society of Mining Engineers of the AIME is an indication of professional identity and the mark of the individual who wishes to contribute with pride to the growth of his profession. Such growth is a dual proposition: as the Society (and Institute) gain prominence in our advancing technological culture, the individual member is enabled to expand his own horizons and skills by his association with a strong professional group. An active part in SME affairs may be gained by direct association with a division of one's choice such as the Minerals Beneficiation Division.

The MBD, through its national and regional meetings and its related publications, is the paramount organization in the U. S. for presentation and exchange of technical information relating to the processing of ores. A vital part of this exchange is embodied in committee activities by which MBD members may gain professional recognition quite apart from publishing technical papers. Membership on MBD technical committees is open to all MBD affiliates and appointments to these committees are based on an indicated willingness to work as a member of a committee team. A letter to your Division Chairman, indicating a desire to serve, will provide the opportunity for association with the MBD administrative group. A demonstrated ability through these activities leads to positions of greater responsibility. This is an effective route to national professional recognition.

The Minerals Beneficiation Division is a dynamic part of the SME and AIME. Its strength arises from the dedicated efforts of individuals with a common interest in a professional field. It has gained international stature as may be seen by the number of foreign papers presented at our Annual Meetings and the additional ones published in our *Transactions*. The Division also sponsors special conferences of an international scope and joins other Divisions of the AIME in joint programs of mutual interest. Regional and local groups, within the U. S., provide even closer bonds among our members to promote individual professional development.

As with almost any organization, each member receives benefits roughly proportional to his own contributions of effort; thus the premier standing of MBD attests to the fact that many renowned engineers and scientists have aided in its growth. We welcome new members and urge all to take part in our activities. If you wish to publish the results of your technical work, or to develop skills in professional administration, or to improve your engineering abilities, or merely to enjoy the stimulating association of engineers with similar interests, MBD has a place for you.—*H. Rush Spedden*

History: The Minerals Beneficiation Division of AIME came into being as a formal part of the Institute at the Feb. 16, 1948, meeting of the Board of Directors in New York. Forerunner of MBD was the Milling Methods Committee of AIME.

Actually the Division was already operating, since it had a fullfledged schedule of sessions and social events at the Annual Meeting then taking place. To quote briefly from Professor Arthur F. Taggart's colorful, well written meeting resume:

"In potential for service to members of the mineral engineering profession the word Division above [in the title of the report, MINING & METALLURGY, March 1948] marks the most important incident in many years. Thanks are due to Ted Counselman for the original idea and for skillful and unremitting work in carrying it through; to Jack Myers for wholehearted enlistment in the fight, and to the Lord, I guess, for endowing him with the capacity to smooth the ruffled feelings it engendered; and to The Dorr Co. and to the Tennessee Copper Co. respectively for sympathetic recognition that these key men had company work so well organized they could properly devote company time, supplies, and secretarial aid to the campaign."

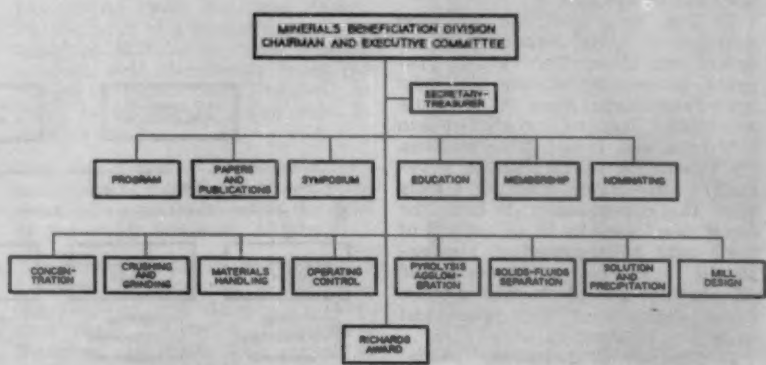
The first Division luncheon was also held in that momentous year, 1948, and at the time announcement was made of the availability of funds for an annual presentation of the Robert H. Richards Award by AIME in recognition of meretorious achievement in ore dressing.

Initial membership in MBD was some 900 pioneers. Today Division roles list over 2000 whose primary interest, among SME members, is minerals beneficiation.

1948 was indeed a banner year, for it also saw the introduction of an event of fame or infamy, depending on your viewpoint—or time of day—or both. The *M & M* Annual Meeting reporter put it this way, in describing that first Scotch Breakfast: ". . . a new standard in matutinal gastronomy."

Today the Scotch Breakfast and Division luncheon are Annual Meeting traditions, playing to a capacity audience. The programs arranged by MBD continue to arouse as much interest and *technical* excitement as did that first program under Division auspices. And MBD was particularly proud in New York in 1960 to have all its meeting papers available as SME Preprints (see the page on *Society and AIME Services*).

MINERALS BENEFICIATION DIVISION



ROCK IN THE BOX

Mining & Exploration Division

R. J. LACY, Division Chairman

Some of the following is based on a recent statement by Mr. Lacy as incoming chairman of the Division for the year 1960. His ideas and hopes for M & E appeared in "Rock in the Box" in the February 1960 issue of MINING ENGINEERING.

The Mining and Exploration Division of SME serves those whose interests are the exploration for and removal from the earth of metallic and nonmetallic ores. Formerly the Mining, Geology, and Geophysics Division of AIME and SME, its members consist of underground and open pit mining engineers, geologists, geophysicists, and geochemists.

Among the benefits and services M & E offers its members are:

1) Just as the trend in the mining industry is toward integration so has M & E increased its own policy of integration. The miners and exploration people are carrying out increasingly coordinated functions rather than operating as separate units as they did in the past.

2) The programs the Division sponsors at AIME Annual Meetings reflect this trend. The various program committees during the past few years have tried to schedule more joint sessions for all Division members and fewer total sessions. By scheduling fewer sessions, especially concurrent ones, M & E'ers have the opportuunity to hear the latest developments in all aspects of their field of engineering. For example, open pit or underground miners have an opportunity to learn about the newest techniques and tools for exploration.

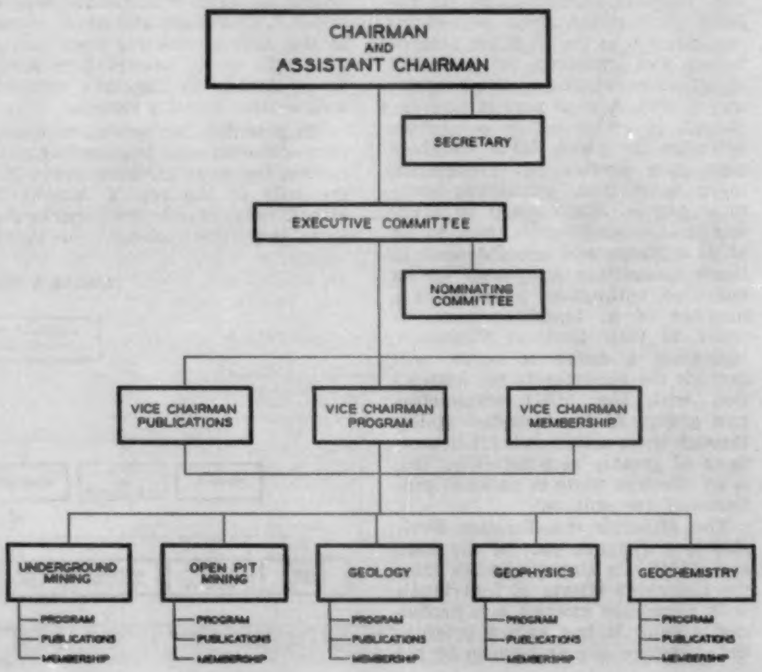
3) MINING ENGINEERING, official publication of the Society of Mining Engineers of AIME, serves Division members. Their newsletter, *Rock in the Box*, is carried in most issues during the year. This newsletter keeps members abreast of Division business, helps acquaint M & E'ers with their officers and projects of their part of SME, and serves as a sounding board for ideas and interests. Letters to the editor, published last year, informed miners and explorers of technical highlights of a number of non-AIME meetings. These were meetings most Division members could not attend. Actually, any member can use *Rock in the Box* as a "sounding board" for a pet project or idea or grievance just by addressing a letter to the editor.

MINING ENGINEERING serves M & E'ers in many other ways. Numerous articles throughout the year are devoted to topics within the Division's field of interest. An *Abstracts* column not only gives handy reference digest of papers in a given issue but also those presented at meetings of interest to SME members. The *Mineral Information Section* gives data on current technical literature from leading publishers, state agencies, and many foreign countries.

History: The Division (under the name Mining, Geology, and Geophysics Division of AIME) was founded in the fall of 1949, an outgrowth of the activities of several former committees of the Institute. In 1958 the name was changed to Mining and Exploration Division and a certain amount of reorganization was effected in order to both broaden the scope of the Division and provide greater cohesion.

Organization: Today, M & E's basic organization is the Unit system, one each for open pit mining, underground mining, geology, geophysics, and geochemistry. However, to preserve the integration attained by the Division, the various committees of each Unit (program, publications, membership) are responsible to a Division vice president who coordinates the activities of the five units.

MINING AND EXPLORATION DIVISION



SME OFFERS PROFESSIONAL RECOGNITION

Through AIME and SME, individual engineers attain professional recognition when they are named recipients of major awards. This page is devoted to the awards of interest to members of SME. The captions accompanying the pictures explain what aspect of professionalism the award represents.

The James Douglas Gold Medal recognizes distinguished achievement in nonferrous metallurgy including both beneficiation of ores and alloying and utilization of nonferrous metals. (Above.)

The William Lawrence Saunders Gold Medal recognizes distinguished achievement in mining other than coal. The term "mining" includes the production of metals and nonmetallic minerals. (Above.)

The Charles F. Rand Memorial Medal is awarded at such a time and under such rules as may be determined by the Board of Directors of AIME for distinguished achievement in Mining Administration. The term "mining" is defined in its broader sense to include metallurgy and petroleum. (Above.)

The Erskine Ramsay Gold Medal is awarded in recognition of distinguished achievement in coal mining including both bituminous and anthracite coal. (Above.)

The Robert H. Richards Award recognizes achievement in any form which unmistakably furthers the art of minerals beneficiation in any of its branches. (Not illustrated.)

The Rossiter W. Raymond Award (in the form of a certificate and check) is given annually for the best paper published by a member of the Institute under 33 years of age. Not only technological content but literary quality are considered.

The Robert Peele Memorial Award (in the form of a certificate), established in 1954 by the then Mining, Geology, and Geophysics (now the Mining & Exploration Division), is given to encourage young men in creative work.

The Hal Williams Hardinge Award was recently established to recognize outstanding achievement in the field of industrial minerals. (Right.)

The Daniel C. Jackling Award and Lecture was instituted by the Mining, Geology, and Geophysics Division (now Mining & Exploration Division) in 1953. The award is presented for significant contributions to technical progress in the fields of mining, geology, and geophysics. The recipient is the Jackling Lecturer at the AIME Annual Meeting. (Lower left.)

In addition to these awards presented in recognition of achievement on a professional basis, each of the constituent Societies of AIME may give annually an award to students for papers submitted in the Annual National Prize Paper Contest. SME may give an award of $100 each for a paper in the graduate class and for one in the undergraduate class. These presentations are made at the welcoming luncheon during the Annual Meeting of the Institute.

The Institute also cooperates with the other Founder engineering societies in the presentation of certain awards:

The John Fritz Medal is awarded for notable scientific or industrial achievement.

The Alfred Nobel prize is given for a technical paper of particular merit accepted by the publication committee of any of the four—AIME, ASME, AIEE, and the Western Soc. of Engineers—for publication, in whole or in abstract, in any of their respective technical publications, provided the author, at the time the paper is accepted in practically its final form, is not over 30 years of age.

The third joint award of the Founder Societies is the Hoover Medal. Named in honor of Herbert Hoover, Past-President of AIME and former President of the United States, the medal is awarded for distinguished public service by an engineer.

The Percy Nichols Award is given for notable scientific or industrial achievement in the field of solid fuels. Given under the joint sponsorship of AIME and ASME, the Award is presented at the Annual Joint Meeting of the Coal Division of SME and the Fuels Division of ASME.

SOCIETY AND AIME SERVICES

Described below are some of the services provided by the Society and the Institute and available to you as a member of SME of AIME. They range from papers and books to personnel service.

Preprints—As a service to its members, the Society of Mining Engineers preprints papers presented at the Society meetings. In 1960 approximately 116 Annual Meeting papers, presented at New York in February, were preprinted and available on a coupon basis to members and nonmembers of the Society of Mining Engineers.

In order to make this program financially feasible, preprints are distributed on a coupon basis. Each member of SME receives with his annual dues bill a book of five free coupons which entitles him to five preprints. If he should attend the Annual Meeting, he receives as part of his registration a second book of five free coupons entitling him to five additional preprints. Thereafter coupon books are available to members for $5 per book of ten coupons. Each coupon is redeemable for one preprint. The Society also sells books of ten coupons at $10 per book to nonmembers. These coupons are again redeemable for preprints.

In addition to the papers preprinted for the Annual Meeting, the Society is also preprinting papers presented at some regional meetings. In 1959 the AIME papers presented at the Joint Solid Fuels Conference of AIME and ASME were preprinted and available to members and nonmembers on a coupon basis. Also available were papers presented at the Bedford Springs Meeting of the Coal and Industrial Minerals Divisions. During the forthcoming year, SME is hoping to expand its preprint coverage of meetings.

Books—In addition to the professional and personal contact function of AIME, the Institute has a major objective the dissemination of technical information of varying kinds. One method of so doing is publication of a monthly technical journal, MINING ENGINEERING, by the Society of Mining Engineers. In addition, the *Transactions* papers, or contributions worthy of inclusion in the permanent technical literature, are collected and published as a bound volume once a year. The present *Transactions* of AIME published under the auspices of the Society of Mining Engineers consists of those transactions papers published monthly in MINING ENGINEERING.

In addition to the annual *Transactions* volume, AIME publishes from time to time books of interest to those engineers in the minerals industry. For example, *The Porphyry Coppers in 1956* edited by A. B. Parsons, was a recent publication of the Institute. *Economics of the Mineral Industry* was a 1959 publication of AIME. Published early in 1960 was a third revision of *Industrial Minerals & Rocks*, edited by J. L. Gillson, 1960 AIME President. A long-needed revision of two earlier volumes, this 900-some page book is truly a monumental contribution to technical literature. From time to time AIME issues an available book list for the information of its members. Members of SME can obtain these books (and those of other publishers) at a discount.

Library—The Engineering Societies Library is located physically in the Engineers Building, home of AIME and the other Founder Societies. It is a department of the United Engineering Trustees, a corporation of which each of the five Founder Societies is a member. Through their membership in UET, the Societies support the Library. ESL is, of course, outstanding in its Founder Societies, fields—civil, electrical mechanical, mining, metallurgical, petroleum, and chemical engineering —but the over 175,000 volumes in the Library cover all branches of engineering, primarily on the level of the graduate practicing engineer. In addition to these reference works, the Library currently receives over 1500 periodicals from all parts of the world.

The reading room of the Library is available to anyone, whether member or not of the Founder Societies.

The Library offers special services such as preparation of bibliographies; literature searches; and translation, photoprint, and microfilm copying of material contained in the Library. Such services can be ordered by mail. The Library will be glad to furnish a brochure of its services and charges therefor upon request.

ESPS—The Engineering Societies Personnel Service Incorporated is a nonprofit, self-supporting national employment service cooperating with various engineering societies, of which AIME is one. With offices in Chicago, New York, and San Francisco, engineering employment services are available for employer and employe. The range of jobs listed for engineers includes every field of industry and government from production, administration, consulting, to editorial and sales. ESPS carries a listing of available engineers as well as positions open.

EJC—Engineers Joint Council is a federation of Professional Societies whose memberships total a quarter of a million engineers (AIME is a constituent society). EJC is dedicated to the betterment of the nation and to the professional and sociological development of the individual engineer. Societies in special fields serve members in their particular areas by EJC represents the broad engineering profession and works for engineering by promoting sound public recognition of the engineer.

Some of the areas to which EJC's jurisdiction extends are national manpower policy, engineers' employment conditions in industry, science and engineering education, secondary and technical school education, national resources policies, international standards, labor management relations, and developments such as nuclear energy.

The fourfold constitutional objectives of EJC are 1) to advance the general welfare of mankind through the available resources and creative ability of the engineering profession 2) to promote cooperation among the various branches of the engineering profession, 3) to advance the science and profession of engineering, and 4) to develop sound public policies respecting national and international affairs wherein the engineering profession can be helpful to the services of the engineering profession.

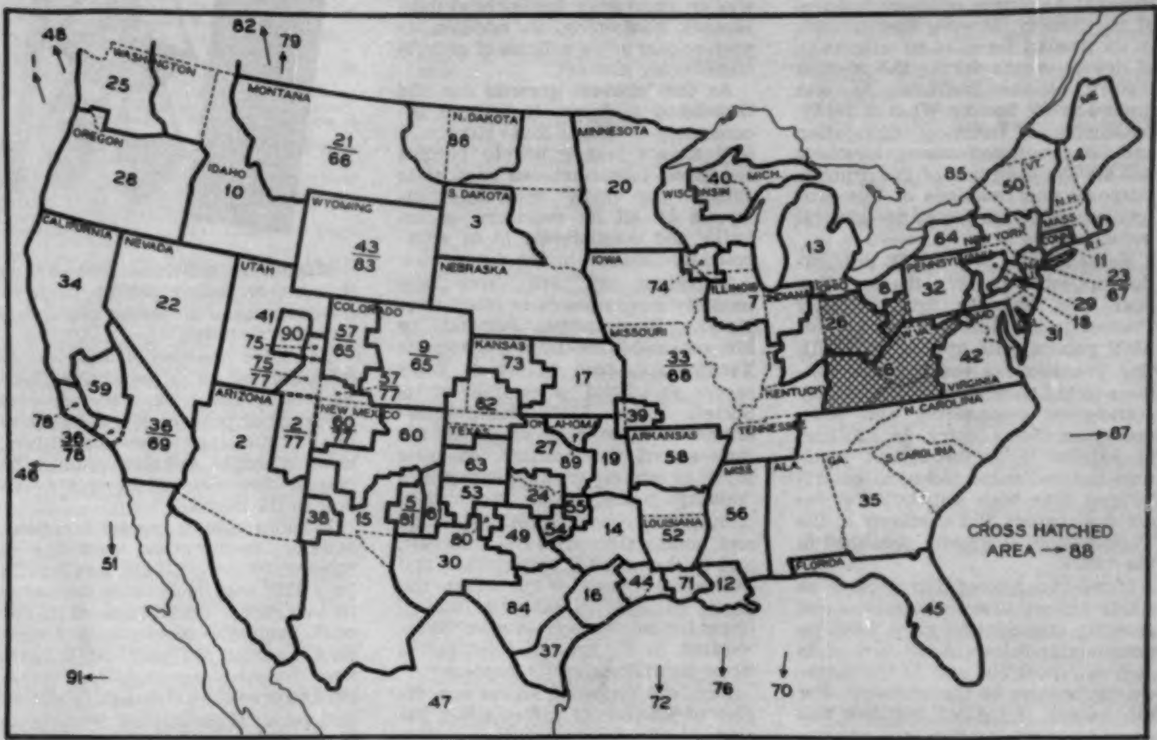
To achieve these objectives EJC acts as an advisory and coordinating agency to work out and study matters of mutual interest to the constituent societies and to recommend parallel action by them. EJC represents the constituent societies of the council in instances in which the constituent societies deem such joint representation desirable. EJC also administers, on behalf of the engineering profession, those activities authorized by a majority of the societies.

Several major annual events are held under the auspices of EJC. One is the general assembly, normally scheduled for January, which brings engineers together with world authorities on subjects of broad interest to the engineer in the profession. The Nuclear Congress, first held in 1955 and again in 1957, became in 1958 an annual event controlled by EJC's permanent policy committee on nuclear congresses. In addition to these events other conferences are arranged as the need arises. By joining the Society of Mining Engineers of AIME, an engineer can participate in the conferences and programs of Engineers Joint Council.

AIME LOCAL SECTIONS

Professional Activities at Your Doorstep

As is shown by the map below, AIME Local Sections cover the U. S. and many other parts of the world (see the Section list). Members of the Society of Mining Engineers find a professional group—their Local Section—in key industry areas throughout the country. These Local Sections are served by AIME headquarters but elect their own officers and conduct their own affairs, providing the broad base from which the strength of AIME stems.



Numerical Code to Local Section Map

1 Alaska
2 Arizona
3 Black Hills
4 Boston
5 Carlsbad Potash
6 Central Appalachian
7 Chicago
8 Cleveland
9 Colorado
10 Columbia
11 Connecticut
12 Delta
13 Detroit
14 East Texas
15 El Paso
16 Gulf Coast
17 Kansas
18 Lehigh Valley
19 Mid-Continent
20 Minnesota
21 Montana
22 Nevada
23 New York
24 North Texas
25 North Pacific
26 Ohio Valley
27 Oklahoma City
28 Oregon
29 Pennsylvania-Anthracite
30 Permian Basin
31 Philadelphia
32 Pittsburgh
33 St. Louis
34 San Francisco
35 Southeast
36 Southern California
37 Southwest Texas
38 Southwestern New Mexico
39 Tri-State
40 Upper Peninsula
41 Utah
42 Washington, D. C.
43 Wyoming
44 Spindletop
45 Florida
46 Philippine
47 Mexico
48 Southwestern Alaska
49 West Central Texas
50 Adirondack
51 Peru
52 Lou-Ark
53 South Plains
54 Fort Worth
55 Dallas
56 Mississippi
57 Colorado Plateau
58 Arkansas
59 San Joaquin
60 Central New Mexico
61 Hobbs
62 Hugoton
63 Panhandle
64 Niagara Frontier
65 Denver Petroleum
66 Billings Petroleum
67 New York Petroleum
68 Illinois Petroleum Basin
69 Los Angeles Basin
70 Eastern Venezuela Petroleum
71 Evangeline
72 West Venezuela
73 Great Bend
74 Upper Mississippi
75 Uranium
76 Caracas
77 Four Corners
78 California Coastal
79 CIM-AIME Calgary
80 Snyder
81 Roswell
82 CIM-AIME Edmonton
83 Wyoming Mining & Metals
84 Balcones
85 Hudson-Mohawk
86 Williston Basin
87 Saudi Arabia
88 Appalachian Petroleum
89 Northern Oklahoma
90 Utah Coal
91 Sumatra

Local Sections' Alphabetical List

1 Alaska
50 Adirondack
88 Appalachian Petroleum
2 Arizona
58 Arkansas
84 Balcones
66 Billings Petroleum
3 Black Hills
4 Boston
76 Caracas
5 Carlsbad Potash
6 Central Appalachian
60 Central New Mexico
7 Chicago
79 CIM-AIME Calgary
82 CIM-AIME Edmonton
8 Cleveland
9 Colorado
57 Colorado Plateau
10 Columbia
11 Connecticut
78 California Coastal
55 Dallas
12 Delta
65 Denver Petroleum
13 Detroit
14 East Texas
70 Eastern Venezuela
15 El Paso
71 Evangeline
45 Florida
54 Fort Worth
77 Four Corners
73 Great Bend
16 Gulf Coast
61 Hobbs
85 Hudson-Mohawk
62 Hugoton
68 Illinois Basin Petroleum
17 Kansas
18 Lehigh Valley
51 Lima, Peru
69 Los Angeles Basin
52 Lou-Ark
47 Mexico
19 Mid-Continent
20 Minnesota
56 Mississippi
21 Montana
22 Nevada
23 New York
67 New York Petroleum
64 Niagara Frontier
89 Northern Oklahoma
25 North Pacific
24 North Texas
26 Ohio Valley
27 Oklahoma City
28 Oregon
63 Panhandle
29 Pennsylvania-Anthracite
30 Permian Basin
31 Philadelphia
46 Philippine
32 Pittsburgh
81 Roswell
33 St. Louis
34 San Francisco
59 San Joaquin
87 Saudi Arabia
80 Snyder
35 Southeast
36 Southern California
53 South Plains
37 Southwest Texas
48 Southwestern Alaska
38 Southwestern New Mexico
44 Spindletop
91 Sumatra
39 Tri-State
74 Upper Mississippi Valley
40 Upper Peninsula
75 Uranium
41 Utah
90 Utah Coal
42 Washington, D. C.
49 West Central Texas
72 Western Venezuela
86 Williston Basin
43 Wyoming
83 Wyoming Mining & Metals

MINING ENGINEERING — SME's MAGAZINE

Mining Engineering is the official magazine of the Society of Mining Engineers of AIME. Published monthly, it is one of the leading publications serving the mineral industry. As a member of SME you receive a subscription.

History: As is true of many features of the Society, Mining Engineering, in its present form, is an outgrowth of developments during the 89-year history of the Institute. As was quoted in the Section *What Is SME?*, publication of technical information and its circulation among members has always been one of the primary purposes and functions of this professional organization in the mineral industries.

Actually, the first AIME publication appeared in 1871, the founding year, and was the first of many *Transactions* volumes (Vol. 214 for SME papers will appear in 1960). The *Transactions* contain contributions to the permanent technical literature on engineering and technology in the industry. In addition, at various times throughout Institute history, these technical contributions have been distributed as individual papers and quarterly in the *Technologies*, originally published in the 1930's.

It was recognized fairly early in AIME history that any vigorous and growing organization must keep its membership informed not only of its own activities but also of the newsworthy events of the industry. For this reason, the AIME *Bulletin* was started in 1905. At first bimonthly, it became a monthly in 1908. During its years of publication, the *Bulletin* contained such data as news of Institute meetings and business affairs, lists of new members, various announcements and notices of general interest, and advertising.

Mining and Metallurgy became its hardy successor (formally in January 1920) as the regular monthly magazine of the Institute. For many years this publication served as a cohesive element in AIME affairs; it went to all members and contained news material of interest to all. It was an aggressive, commercial publication, containing, in addition to professional news, articles of general engineering interest.

As the Institute grew in size and broadened in scope, it became increasingly evident that Mining & Metallurgy was either to become too broad in format and content to satisfy the many diversified interests of all its members or too bulky and cumbersome to be economically feasible in the future.

Therefore, in 1949 three new monthly magazines came into being: Mining Engineering, Journal of Metals, and Journal of Petroleum Technology, each of which today serves as official publication of its Society within AIME. Mining Engineering then—as now—served the interests of the industry: covering topics of interest to those engaged in "mining geology and exploration, mining and beneficiation of metallic and nonmetallic ores and minerals, and in the mining, preparation, and utilization of coal," to quote from the initial editorial in January 1949.

Organization Today: Mining Engineering in its present form serves three functions for its readers.

First, the magazine serves as a digest of sources of information. Included in the front section are notices of coming events; jobs; a comprehensive survey of current literature in the field, published here and abroad; abstracts of papers published and presented at meetings; reports of recent developments and publications by manufacturers; and in each issue, a summary of industry news.

Mining Engineering provides, as its core, an article section containing coverage of all phases of mineral industry activity.

The third function of the monthly is presented in a newspaper-type section in the back. This provides coverage of professional and Society affairs, meetings past and future, news of people, and also contains the largest directory of services available in the industry.

In addition to its regular functions, Mining Engineering performs a number of *once-a-year* services. In July SME uses its monthly journal as its vehicle for distribution of its annual, complete Membership Directory. Late in the year, SME again uses the magazine to furnish members with as complete data (program and paper abstracts) as possible on the forthcoming Annual Meeting, held each February.

Mining Engineering also serves members of the Society by presentation of an *Annual Review*, devoted to summary of industry developments and progress in the year past as well as prognostications for the future.

SME's Programs: Its monthly journal is part of the overall Society publications program which includes preprints, magazine, and the annual *Transactions* volume.

Each of these three media fulfills a specific role: 1) Preprints are intended for rapid dissemination at low cost of information presented at meetings. The Preprint program is set up so that not only members attending meetings, but also those who could not, can have the text of papers presented as quickly as possible. 2) The monthly magazine performs the three functions outlined above, as well as providing a media for "special" information or service. 3) The annual *Transactions* fulfill their historic role as reference volumes and a consistent series in the permanent technical literature of the mineral industries.

Thus, through its publications, SME serves you, its members.

NOTICE – SME PREPRINT AVAILABILITY, 1960 ANNUAL MEETING

The following list of papers (from the 1960 New York Annual Meeting) will be available until Jan. 1, 1961. Coupons received with the 1960 dues bills and those distributed at the 1960 Annual Meeting will also expire on this date. Purchased coupons books will be honored on any future date. A new listing of available papers will appear in a forthcoming issue. It will include additional papers presented at the 1960 Annual Meeting (New York) and at other SME meetings throughout the year. **Preprints may be obtained (upon presentation of properly filled out coupon) from SME Headquarters, 29 W. 39th St., New York 18, N. Y.** Coupon books may be obtained from SME for $5 a book (10 coupons) for members or $10 a book for nonmembers. Each coupon entitles the purchaser to one preprint.

Coal (F)

Coe, G. D., and Keller, G. E.: *Tube Furnace Method for Rapid Determination of Sulfur in Coal.* **60F40**
Corriveau, M. P., and Coll, H. F.: *Solving the Flocculation Problem.* **60F59**
Davis, D. H.: *Mechanized Tamping of Mine Haulage Roads.* **60F80**
Ellison, L. D.: *Efficient Pillar Extraction by Means of Exhaust Ventilation.* **60F33**
Kamper, O. W.: *The Exploration and Mining of Raw Materials-Production of Refractory Products-Application for the Utilization of Coal.* **60F30**
Lucas, J. R.: *A Field Study in Acid Mine Drainage.* **60F35**
Mason, J.: *Daily Maintenance and Complete Overhaul of Continuous Miners.* **60F65**
Morris, F. M.: *Moss Number 3 Mine: The Materials Handling Aspect.* **60F44**
Osmanski, J. E.: *The Communications Challenge of Automation.* **60F104.**
Poundstone, W. N.: *Face Ventilation in Development with Continuous Miners.* **60F32**
Rao, P. D., Charmbury, H. B., and Mitchell, D. R.: *Crushing of Anthracite for the Reduction of Domestic to Steam Sizes.* **60F74**
Ridenour, D. C.: *Ventilation of Very Gassy Mines Making Use of Large Diameter Bore Holes.* **60F34**
Sargeant, L.: *Ventilation of Conventional Development in Gassy Coal Mines.* **60F57**
Spindler, G. R., and Poundstone, W. N.: *Experimental Work in the Degasification of the Pittsburgh Coal Seam by Horizontal and Vertical Drilling.* **60F106.**
Stachura, J. A.: *Selecting the Proper Type of Continuous Miner.* **60F49**
Updegraff, L. A.: *Continuous and Automatic Measurement of Moisture in Coal by Capacitance.* **60F21**

Economics (K)

Barr, V. L.: *A New Performance Measure to Test the Contribution of the Petroleum and Natural Gas Industry in an Expanding Economy.* **60K53**
Belton, A. E.: *Foreman's Incentive Plan.* **60K39**
Elver, R. B.: *St. Lawrence Seaway and the Canadian Mineral Industry with Particular Reference to Iron Ore.* **60K78**
Farrier, H. M.: *Trends in Property Acquisitions and Mergers in the Oil Industry Since 1954.* **60K76**
Jaworek, W. G., and Shanz, J. J., Jr.: *Bituminous Coal Consumption—Estimating Its Long Term Growth and Annual Variations.* **60K33**
Mathewson, M. H.: *Production Management Incentive Compensation Systems at I.M.C.* **60K66**
McGann, P. W.: *A Method of Projecting U. S. Petroleum Supply.* **60K64**
McGregor, J. L.: *Incentives Bonus Systems.* **60K54**
Morgan, J. D., Jr.: *U. S. Strategic Materials Stockpiles and National Strategy.* **60K50**
O'Leary, V. D.: *The Butte Contract System.* **60K22**
Peterson, W. H.: *The Question of Government Oil Import Restrictions.* **60K60**
Ridge, J. D.: *World Trade in Metal Raw Materials.* **60K107.**
Wang, K. P.: *Rich Mineral Resources Spur Communist China's Bid for Industrial Power.* **60K108.**
Waterland, J. K.: *Incentive Pay System at the Homestake Mining Company.* **60K23**

Geology (I)

Gauvin, C. J.: *Geological Procedure and Control at Steep Rock Iron Mines, Ltd.* **60I45**
Macdonald, R. D.: *Iron Deposits of the Wabash Lake Area, Newfoundland, Labrador.* **60I67**
Riddell, John E.: *A Review of Geochemical Prospecting Practice in Glaciated Pre-Cambrian Terrains.* **60I116.**
Sales, R. H.: *Critical Remarks on the Genesis of Ore as Applied to Future Mineral Exploration.* **60I79**
Schmitt, H. A.: *The Application of Geology to Mining in the Southwest.* **60I93**
Stringham, B.: *Differences Between Barren and Productive Intrusive Porphyry.* **60I97.**
Swenson, W. I.: *Geology of the Nakina Iron Property, Ontario.* **60I43**
Tupper, W. M., Jensen, M. L., and Hurley, P. M.: *The Genesis of the Sulfide Deposits of Northern New Brunswick—An Interpretation Based on Sulfur Isotopic Studies.* **60I68**

Geophysics (L)

Denen, W. H., and Linder, H.: *Relationship of Graphite in Soils to Graphite Zone.* **60L6**
Gross, G.W.: *Location of Clay Deposits by Combined Self-Potential and Resistivity Surveys.* **60L2**
Hawkes, H. E.: *Status of Geochemical Prospecting in the USSR.* **60L15**
Kellogg, W. C.: *A Report on Airborne AFMAG, the Theory, Equipment, and Operation in Western United States.* **60L113.**
Swanson, H. E.: *Model Studies of an Apparatus for Electromagnetic Prospecting.* **60L83**

Industrial Minerals (H)

Ball, D.: *Underground Gas Storage Effects on Underground Waters.* **60H13**
Bays, C. A., Peters, W. C., and Pullen, M. W.: *Solution Extraction of Salt Using Wells Connected by Hydraulic Fracture.* **60H100.**
Boos, M. F.: *Pegmatites and Their Mineralization in the Storm Mountain Area, Larimer County, Colorado.* **60H29**
Brown, O. E.: *Use of the Coulter Counter for Particle Size Analysis of Cement and Related Material.* **60H71**
Castleberry, D.: *Fragmentation Studies in a Georgia Granite.* **60H20**
Cazott, J. G., Jr.: *Development of a Bauxite Deposit Using Dredging as the Stripping Method.* **60H16**
Comstock, H. B.: *Trends in Production and Use of Magnesium Compounds in the U. S.* **60H88**
Dobbs, E. H.: *Missouri-Oklahoma Type Tripoli.* **60H41**
Gillam, W. S.: *The Cost of Converted Water.* **60H14**
Hershey, R. E.: *Phosphate Raw Materials of Tennessee.* **60H17**
Hoyt, F. D., and Hartman, H. L.: *Developments and Research in the Sawing of Dimension Stone.* **60H46**
Irving, D. R.: *Some Beneficiation Techniques Applicable to Mineral Fillers.* **60H48**
Jenkinson, D. W.: *Progress Report on Beneficiation of Aggregates by Heavy Media Separation.* **60H82**
Kadey, F. L., Hutta, F. B., Jr., and Weymouth, L. E.: *A Study of the Abrasive Action of Fine Powders.* **60H56**
Kazmann, R. G.: *Water: Industrial Mineral—And Industrial Nuisance.* **60H3**
Kingman, O.: *Grade Control at Tennessee Copper Company.* **60H92**
Krueger, A. R.: *Quarried Stone Meets the Challenge of Contemporary Architecture.* **60H85**
Lawrence, W. G.: *Inorganic Materials Research in the USSR.* **60H9**
Michaelson, S. D., Ensign, P. H., Hubbard, S. J., and Last, A. W.: *Water, A Raw Material for the Production of Copper.* **60H98.**
Moyd, L. and P.: *The Gamma-Ray Neutron Beryllium Detector as a Reconnaissance Tool.* **60H96.**
Piper, J. D.: *Concrete Technology in the USSR.* **60H27**
Ploetz, G. L., and Muccigrosso, A. T.: *Applications for Lanthanon Oxides and Other Compounds in the Ceramic Industry.* **60H87**
Robinson, G. C.: *Lightweight Clay Block Using Vermiculture.* **60H47**
Thomson, R. D.: *Nonmetallic Mineral Fillers in Plastics.* **60H105.**
Whitman, J. H.: *Evaluation and Merketing of Rare Earth Deposits, Ores, and Concentrates.* **60H42**
Weisz, W. H.: *The Role of Gypsum in Portland Cement.* **60H111.**
Wykes, C. E.: *Development of Extreme Settings on Deep Well Turbine Pumps.* **60H1**

Open Pit Mining (AO)

Hunter, P. L.: *Industrial Accident Prevention and Health.* **60AO31**
Livingston, C. W.: *The Application of Explosions Research to Blasting in Mines and Quarries.* **60AO26**
Nalle, P. B., and Weeks, L. W.: *The Use of Digital Computers in the Mining Industry.* **60AO62**
Stefanko, R.: *Underground Stress Instrumentation.* **60AO51**
Trollope, D. H.: *The Mechanics of Rock Slope.* **60AO37**
Grosvenor, Niles E.: *A Method for Determining The True Tensile Strength of Rocks.* **60AO115**

Minerals Benefication (B)

Agar, G., and Charles, R. J.: *The Size Distribution Shift in Grinding.* **60B5**
Arbiter, N., and Bhrany, U. N.: *Correlation of Product Size, Capacity, and Power in Tumbling Mills.* **60B99.**
Aubrey, W. M.: *Automatic Thickener Control at Marmoraton Mining Company.* **60B25**
Barnes, J. W.: *Process Control in Uranium Mills—How Far Can Automation Go?* **60B96.**
Bergstrom, B. H., Sollenberger, C. L., and Mitchel, W., Jr.: *Energy Aspects of Single Particle Crushing.* **60B102.**
Bitsianes, G.: *Problems in Magnetic Roasting of Marginal Iron Ores.* **60B84**
Bleimeister, W. C., and Brison, R. J.: *Beneficiation of Rock Salt at the Detroit Mine of International Salt Co.* **60B8**
Bouchat, M. A., Detiege, A., and Robert, D.: *Magnetic Recovery of Germanium Sulfide with the Franz Ferrofilter.* **60B38**
Brison, R. G., and Tangel, O. F.: *Development of a New Dry Method for Mineral Separation.* **60B7**
Brown, J. H., Mitchell, S. R., and Weissman, M.: *Energy-Size Reduction Relationship for the Grinding of Quartz.* **60B28**
Cazort, J. G., Jr., and de Witte, J. J.: *Intra-Plant Transportation and Handling of Bauxite at Suralco's Paranam, Suriname, South America Works.* **60B81**
Dahlstrom, D. A.: *Basic Concepts and Automatic Control of Continuous Filtration.* **60B110.**
Dailey, W. H., Jr., and Bunge, F. H.: *The Reaction of Low Grade Nonmagnetic Iron Ores to Magnetic Roasting in a Fixed Bed.* **60B58**
Edwards, J. R. J., and Salamy, S. G.: *The Magnetic Reduction of Jaspilite in a Shaft Furnace.* **60B4**
Emmett, R. C., and Dahlstrom, D. A.: *Application of Continuous Filtration to Precipitate Dewatering.* **60B114**
Fuerstenau, S. W.: *Retention Time in Continuous Vibrating Ball Milling.* **60B10**
Gilvarry, J. J., and Bergstrom, B. H.: *Fracture and Comminution of Brittle Solids.* **60B103**
Grothe, J. D.: *Laboratory Experiments and Their Relation to Plant Design.* **60B69**
Gump, J. R.: *Commercial Separation of the Heavy Rare Earths by Ion Exchange.* **60B86**
Laurila, E. A., Saari, L., and Castren, O.: *An X-Ray Fluorescence Spectrometer for the Line Analyses of Titanium in Ilmenite.* **60B19**
Lewis, C. J., and House, J. E.: *The Recovery of Molybdenum by Liquid-Liquid Extraction from Uranium Mill Circuits.* **60B72**
Massey, E. M.: *Influence and Application of Rope Sideframe Belt Conveyors to Surface Coal Handling Facilities and Preparation Plant Design.* **60B63**
McLean, D. C., and Padilla, V.: *A Study of Oxidation and Cyanide As An Oxidation Catalyst in Pressure Leaching of Uranium.* **60B94**
Merklin, K. E., and Childs. M. H.: *Some Factors Influencing the Physical Qualities of Iron Ore Pellets.* **60B75**
Mitchell, G. R., Berman, H. L., and Goldberg, A. E.: *The Infrared Radiometric Method and Its Application to Remote Temperature Measurement.* **60B18**
Rampacek, C., and McKinney, W. A.: *The Copper Segregation Process.* **60B61**
Russell, R. J.: *Considerations in Selecting Grinding Equipment.* **60B55**
Sausa, L. E., and Martinson, J. E.: *Pulp Density Measurement and Control.* **60B24**
Schuhman, R., Jr.: *Energy Input and Size Distribution in Comminution.* **60B11**
Smith, et al. (Compilation of Abstracts).: *Symposium on Surface Phenomenon in Mineral, Ceramic, and Metallurgical Systems.* **60B12**
Titkov, N. P., and Yegokin, A. N.: *Development of Technology for the Beneficiation of Hematite Ores.* **60B109**
Wade, H. H., and Schulz, N. F.: *Magnetic Roasting of Iron Ores in a Traveling Grate Roaster.* **60B36**
Young, R. K.: *Setting Up a Project Organization for Efficient Mill or Plant Design.* **60B101**

Underground Mining (AU)

Buchanan, J. F., and Buchella, F. H.: *History and Development of the San Manuel Mine.* **60AU90**
Hayes, L. G.: *Tri-State Zinc Inc. Bowers-Campbell Mine, Timberville, Virginia.* **60AU77**
Kostuik, J., and deBastiani, M. J.: *Mine Operations at Consolidated Denison Mines Limited, Elliot Lake, Ont.* **60AU89**
Newell, T. W., and Appelin, C. W.: *Small Mine Operations—Shattuck Denn's Bardon Mine.* **60AU73**
Robbins, H. E., Dunston, W. H., and Dudley, T. H.: *Andes Copper Mining Company Development of El Salvador Mine.* **60AU70**
Weehuizen, J. M.: *The Sinking of Two Shafts for the New Beatrix Mine by the Drilling Method.* **60AU91**

Paley Report Series—No. 5

REALIGNMENT OF PREDICTIONS OVER THE NEXT FIVE YEARS

by S. G. LASKY

Abraham Lincoln is reputed to have said that if you want to chart a course to some destination, you have to know where you are starting from. In this instance we have to define our starting point in a double manner:

1) What was the theoretical basis of the Paley predictions?

2) What actually did the Commission predict, so that we can see how the predictions have worked out up to now as a basis for considering how they may have to be changed.

What the Paley Commission Believed: The Paley report is often—almost always, in fact—misquoted as saying that consumption and supply of some commodity will be thus-and-so by 1975. Actually, "1975" refers to the decade 1970-1980, and the projections are expected to indicate only "the plausible shape of things in that decade" and "to give only the roughest measure of the general magnitude involved." The Commission selected 1975 as the terminal date, instead of some other point in time, as being not "so far off as to be dominated by technologic or other developments now wholly unforeseeable."

The basic assumption of the Paley report is that the U.S. will grow, as measured by the value of goods and services produced, at the same rate it has averaged over the past century—about 3 pct a year. This amounts to a doubling every 25 years.

On that assumption, and on the general philosophy the writer has quoted, the Commission concluded that by 1975 the demand for metals and minerals as a whole will be 90 pct higher than in 1950. That is, demand for minerals will increase by 90 pct while the Gross National Product grows 100 pct. That comes about because they believed that fabrication will add an ever increasing value step by step and that year by year the Gross National Product will tend to reflect an increasing proportion of services.

The Commission did not insist on this projection. It acknowledged that there will be wide differences in opinion about it. What it did insist on is that, whatever the percentage figure, "demand for everything can be expected to rise substantially."

It also believed that there will be growing difficulty in meeting the increased demand, and it posed this startling question: "Has the United States of America the material means to sustain its civilization?" It added that there is a "strong possibility of an arrest or decline in our standard of living"—not that we will wake up some morning to discover that we have pumped the last barrel of oil or hoisted the last ton of lead ore, but that the cost of getting the material we need will rise disastrously.

"In short," the Paley Commission concluded, "the essence of the materials problem is costs," that is, the work and capital required to bring a unit of material into useful form.

What the Commission Predicted and the Record to Date: Now let us see what the Commission predicted and how the predictions have worked out over the last seven years.

First, relating to demand:

If we stay with generalities, the Paley record as of now seems good. Skeptics will say that although the answer came out right, it did so for the wrong reasons, particularly in view of the fact that the Commission underestimated population growth. Others will retort that too many imponderables are involved for anyone to judge whether any economic formula is correct or incorrect—that the real test is the test of history.

Seven years is not much of a span of history to go by, but it is all we have. By this test of "history," the Paley record on the generalities is, as noted, good. Gross National Product has followed the 3 pct trend-line fairly faithfully for the past seven years, and the actual and projected 1957 figures—on straight-line projection from 1950 to 1975—are almost identical. As judged from the 24 principal mineral items on which the writer has information, U. S. consumption also has followed the Paley 1950-1975 trend-line closely, that is, it has increased at a rate about 90 pct as fast as the Gross National Product. The projected percentage increase hits the actual estimated figure almost on the nose. Interestingly enough, domestic production of all mineral raw materials appears to have been increasing at the same rate as consumption.

Of the 17 items for which the Commission made projections of demand, actual 1957 consumption of nine of them was within 10 pct of the Commission's figure on a straight-line projection from 1950 to 1975. Considering the Commission's credo as summarized above, and particularly the fact that only by accident may a specific midpoint year fall on a projected line, that is not a bad record. If we consider that even a 20 pct margin of error would

S. G. LASKY is Staff Assistant for Minerals, Technical Review Staff, Office of the Secretary, U. S. Department of the Interior, Washington, D. C. He was a consultant to the Paley Commission.

be reasonable, then the Commission's record is good for four or five more, including lead and zinc. Only two projections were way off: 1957 consumption for cobalt was 50 pct lower than the Paley estimate would lead us to look for, while aluminum consumption was a sturdy 100 pct higher. On the other hand, the Commission itself placed less confidence in its aluminum figure than in the others.

The projections for Free World consumption are not so good as those for the U. S. alone, but they are still creditable. Generally speaking, the Commission tended to underestimate the growth of world demand, but even so about half of the projections at the 1957 year-point seem within 20 pct of the actual figures, including copper, lead, zinc, and aluminum.

And now, with respect to cost:

The Commission concluded that "the pressure against limited resources is boosting real costs," for some items at least. For example, the ultimate rise in the price of lead and bismuth it believed might be relatively severe; ultimate increases were expected also for chrome, nickel, tungsten, and sulfur, but not necessarily for copper or zinc.

As to how the past seven years have lived up to this conclusion—well, this is treacherous ground. Professional economists themselves differ on how to measure costs in the present sense. The available indices are inconclusive, if not conflicting. The value of metals and minerals produced in the U. S. (except fuels) has been rising faster than the Gross National Product. Some price indices have moved up. As compared with a 1947-1949 average and corrected for inflation, the increase by the end of 1956 was 40 pct for the nonferrous metal group, perhaps about 55 pct for all metals, and 55 pct also for iron ore. On the other hand, the index for mineral materials as a whole shows no particular trend at all.

Where from Here? Now that we have determined where we are, we have some chance of judging where we may be going.

The present commentator's assignment is to consider the next five years. But five years is an ambiguous length of time with which to deal. It is neither short nor long. It is far enough in the future for unexpected economic happenings to arise that would throw off a short-term prediction. It is not far enough into the future for the short-term influences to balance out into a trend. A recession or a boom could bracket the whole period, or we might be in the midst of one or the other at the end of the period.

Political factors also could rise and wane in that period. The U. S. strategic stockpiling is now over with, but its effect on world plant capacity and price is still strong. In its place we have the barter program, which surely has its effect on world supply and on prices. We have also the carry-over of the Government's floor-price programs, and legislation designed to assist various segments of the industry. Last year there were international talks in London and in Washington regarding ways of controlling the ups and downs in mineral markets. All such operations are the results of governmental decisions and philosophies, and in the U. S. such philosophies are subject to change with each Congressional election.

And so in offering his idea of how the Paley predictions may fare over the next five years, the writer is not going to try to predict where demand, supply, and the cost level will be by then, but only to suggest the trend that may be showing up by the early to mid-60's.

It is assumed, of course, that there will be no major war during the period to disrupt any trend that may be in the making, although for the longer term the author's conclusions remain the same, war or no war.

War or no war, it is certain that demand will continue to grow substantially. Population growth—plus a constant 7 to 10 pct of raw material supply assigned to defense—guarantees it. There is no sign of diminuation of our national appetite.

Economists generally agree that the Gross National Product will continue its growth at about 3 pct compounded. Leon Keyserling, President Truman's chairman of the Council of Economic Advisors, thinks the growth rate may reach 5 or 6 pct, but he appears to be lonesone in that point of view.

Whatever the rate of growth of G.N.P., consumption of raw materials should grow at a slower rate, and whatever the rate of raw-material demand, there should be no difficulty in meeting it. Here it should be noted that the writer is talking about mineral supply as a whole. There will be shortages of individual items from time to time, and some of the present surpluses may turn into shortages during the period we are considering, but shortages are always temporary, lasting only until the resulting increase in market price generates the effort on the part of miners to seek and find more.

There is no such thing as an absolute shortage of materials, except as this may be considered in terms of a limited geographic area. Assuming world availability, shortage is a matter of price or cost. As phrased by Robert Koenig of Cerro de Pasco before the National Industrial Conference Board in December 1952: "Given a free market, there would be no problem in keeping the supply of raw materials in line with demand at the price level necessary to call up production."

Mineral deposits are no more than special kinds of rock, in which Nature has concentrated the desired material enough for it to be mined and processed and the resulting product transported and sold at a profit. There is an endless amount of "rock" to work on—if we are willing to pay the cost. Thus the problem is still as it was seen by the Commission: to get an adequate supply without boosting prices unduly.

The writer himself foresees no difficulty. If a shortage develops and the society of the time should decide that the effort to find and produce more—as measured by dollars or cents per ton or pound of material—is too much, it will either design around the particular material or turn to a substitute. A substitute is not necessarily inferior. One material may be used in place of another because it performs equal service at less cost, better service at equal cost, or for no other reason than that it is more readily or more certainly available.

It is not the material that is wanted, but the service it performs. Let us not make the mistake of assuming that we shall always be using the same materials or combinations of them. We need look back no more than a few years, or need only consider the high-temperature or atomic-energy technology that is currently developing to appreciate that one of the characteristics of our 20th-century economy is that the use patterns constantly shift. War or no war, long-term sociologic, political, technologic, and economic trends continuously operate to change

them. Additionally in the event of war, technologic progress is accelerated and sometimes also given a change of direction, and use patterns are thus further modified.

We may even see a noteworthy change by the early or mid-60's, the period we are discussing. Who will be willing to predict with confidence which among tungsten, molybdenum, columbium, ceramics, and plastics will win out in the high-temperature field, or which way and by how much the balance between aluminum and copper, and between aluminum and zinc, will tip?

But although the writer foresees no real difficulty in getting a satisfactory supply, perhaps we must go along with the Paley Commission to the extent of acknowledging some general upward pressure on prices. There is an increasing world demand for manufactured products, compounded by an exploding nationalism that in one way or another slows up development or hampers access to raw materials. But the resultant increase in costs need not necessarily be great; in fact, if the cost is accepted, it follows that the society of the time did not consider it too great.

Any cost increase will be countered by improved technology of production, by substitution, or by redesign of the end-product, before the increase becomes a threat to our continued economic growth.

We mining engineers and geologists have already discovered enough of the conventional metals and minerals to make certain that foreseeable technology can be supported for many decades without any disastrous increase in real costs. There is plenty of time and opportunity to seek, find, and develop new materials as mines become exhausted, as items now in use become too costly, or as services are demanded that conventional raw materials cannot furnish, and plenty of time for the redesign of final products to the end that costs remain acceptable within the raw material supply of the time.

In sum, then, broadly speaking, it is reasonable to continue with the Paley projections of demand, though making adjustments for individual commodities as events dictate. This commentator is not, however, as alarmed about costs, or about any arrest in our standard of living, as was the Paley Commission.

STEEL SUPPORTS AT BAWDWIN MINES, BURMA

by F. J. BUDIN

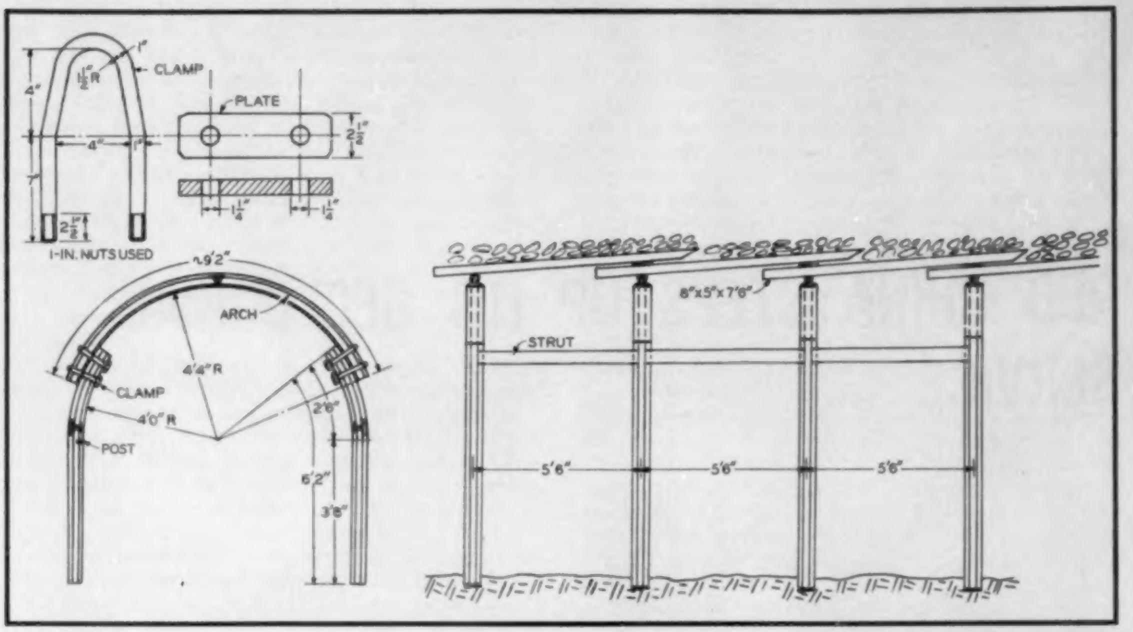
In a remote mining region, ingenuity circumvents problems of supply.

Steel supports are increasingly used in metal mines for junctions, chambers, and other wide openings and for semi-permanent areas such as haulageways, shaft stations, and pump rooms. Steel lasts longer—especially in wet mines and where foul air is present—and is procurable in different sizes that will carry heavier loads than any timber of equivalent cross section. The chief advantage of steel supports is that less excavation is needed than with timber support of the same strength, so that faster progress can be made. Since there is no possible way to calculate the exact weight on supports, sizes must be chosen by experience. Any adjustment and cutting of steel supports underground would be costly and time-consuming, and it is therefore advisable to cut sets beforehand at the surface workshops. This requires standardization of sets.

All these problems have been recognized at Bawdwin Mines, Burma, where mining is difficult, slow, and very expensive. The lead-silver ore is very brittle, with hanging and footwall rock of unconsolidated rhyolite tuff. During the rainy season from May to October water penetrates into the mine, and where soft rock is present disintegration into a loose mass around openings can be expected. For this reason heavy 10x10-in. timber caps break quickly in drifts and crosscuts, and timber rots in a very short time. An average increase of 50 pct in both maintenance work and costs could not be avoided.

In addition to these wholly technical problems there was no possibility of purchasing yieldable

F. J. BUDIN is a Mining Engineer with Burma Corp. Ltd.



arches and profile iron at a reasonable price, since these must be imported from the U. S. or Europe. The decision was made, therefore, to use second-hand rails, 50 lb per ft, available from the corporation-owned railroad, Bawdwin-Namyo. As this proved successful, these rails have also been used for grizzlies, linings, and other purposes.

To avoid wasting this limited supply, and to enable the workshop to build up stock for urgent requirements, steel supports have been standardized in three main sizes: 1) single-rail sets, made up of caps and posts; 2) reinforced rail caps; and 3) yieldable rail arches.

Single-Rail Sets: These sets consist of two 7-ft 6-in. posts and one cap 4 ft 2 in. long connected by an L-iron bolted on the rails with ½-in. bolts. When a drain on one side of the opening is required, 8-ft 6-in. posts are used. These sets average 35 ft in cross section, big enough to allow easy tramming on levels. From the standpoint of rock pressure research, they have all the advantages of an underground support. Since the spiling and lagging are 8 in. x 3 in. x 7 ft and 8 in. x 2 in. x 7 ft, respectively, and the counterface against rock is only 4 in. maximum, the rock will flow around the sets in breaking spiling and lagging. This theory was proved when recovery work was done in old sections of the mine where steel support was in perfect condition, while all timber was rotten or broken; recovery progressed about six times as fast as with equivalent timber support. Shoes (welded plates on posts) are used where the bottom is soft in order to prevent sinking and kipping of sets.

Reinforced Rail Caps: The reinforced caps are used chiefly in main haulageways, junctions, and chambers. They are standardized only for haulageways; any other requirements are made to order. Reinforced rail caps consist of 7-ft double and triple rails (second-hand, 50 lb per ft) parallel-bolted together with ¾-in. bolts. Experience has shown that double-rail caps should be used up to a 10-ft maximum span, and when longer caps are required triple rails are a considerable advantage. The standard cross section of these sets is about 60 sq ft when timber posts are used instead of steel. To facilitate repairs when posts are breaking, 2-in. slide bars are fixed between posts and caps. Installation of spiling is very simple whatever the dimensions (8 in. x 5 in. x 7 ft or 8 in. x 3 in. x 7 ft), and working speed is considerably higher than with normal timber support. These caps seldom break and offer all the advantages of the single-rail sets.

Yieldable Rail Arches: Recently introduced by the author, these arches have proved very successful in maintenance work at the mine. The principal system of yieldable arches has been copied in application to rail arches (see sketch), which comprise one arch and two posts fixed together with clamps. Setting up is simple and can be done rapidly by experienced workmen. The first arch should be fixed in a solid ground, with enough space allowed for 8 in. x 5 in. x 7-ft spiling. Since spiling and lagging can not be advanced for the full length, one intermediate set is required about 3 ft from the first set. After spiling is fully advanced and the next two sets are standing, intermediate sets can be removed and used again, so normal spacing is 5 ft 6 in. The miners work quickly, although these arches have never been seen here before and the men are not specially trained for this kind of work. Cross section allows comfortable tramming in the main haulage with Hudson cars for single lines. According to rock pressure research, yieldable arches should be used wherever there is heavy ground, and this knowledge has been taken into consideration at Bawdwin Mines.

In conclusion it should be emphasized that steel support is not by any means the only solution, especially where mines are in remote areas and steel is not readily available. The mining engineer must solve support problems by using material at hand, as shown here by the adaption of steel rails.

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RED CHINA STEPS UP ITS GEOLOGICAL SERVICE

What do the USSR and Red China report about geologic developments behind the "Bamboo Curtain"? Here is a report based on five recent articles from the Soviet Union.

by EUGENE A. ALEXANDROV

The Minister of Geology of the Soviet Union P.Ya. Antropov, recently visited China and claims that this country occupies one of the foremost places in the world in reserves of tin, tungsten, molybdenum, antimony, iron ore, coal, and phosphates. Occurrences of economic value of chromite, nickel, gold, beryllium, tantalum, niobium, rare earths, and asbestos have also been reported.

MINERAL RESOURCES

Coal: The inferred reserves of coal are estimated at at 1,500 billion tons. A considerable part of the coal reserves is represented by coking coal, 80% of which is bituminous. Thicknesses of coal seams range up to 150 ft in the principal deposits located in northern and northeastern China. The total output of coal in 1958, 270 million tons, was produced by an army of 20 million people mainly in small mines operated by the agricultural communes. Modern hydraulic mining is applied besides primitive, obsolete methods and equipment.

EUGENE A. ALEXANDROV, Member AIME, is an editor of Engineering Index, Inc., New York City. A geologist, he has contributed articles to Economic Geology and the Bulletin of the American Association of Petroleum Geologists.

Oil: Almost 30% of the territory of China has potential oil and gas bearing structures but especially favorable conditions exist in the Szechwan basin in southwestern China where Mesozoic sediments with sandstone reservoirs and favorable structures occupy an area of 76,000 sq mi. Present oil wells in this area produce up to 1400 bbls per day from depths of 3600 to 5300 ft. In the southern part of the basin the reserves of natural gas are estimated in "dozens of billions of cubic meters". Other oil fields have been discovered in northwestern China in the Dzungarian basin. In western China, in the Tsaidam basin, 200 wells are producing oil and gas from Tertiary deposits which attain a thickness of more than 20,000 ft. Additional exploration activity and production is reported from the Dyuchuan basin. Prospecting has been successful in the Turfan basin, in Sinkiang, and on the plain of Sunlyao in northern China where, in one structure occupying an area of 400 sq mi, 22 producing horizons have been discovered in Mesozoic sediments. In addition, reserves of oil shales containing up to 12% extractable petroleum are reported at 18 billion tons. Over 200 field parties were prospecting for petroleum in China during 1958.

Iron: The inferred reserves of iron ore are estimated at 100 billion tons. The indicated reserves are about 6 billion tons. The largest reserves of iron ore are associated with Precambrian formations located in northern China and have an average content of 47% iron. A series of hematite and magnetite ores of contact origin is located in central southern China and new iron ore deposits have been discovered in the provinces of Hupeh and Kwangtung. In 1957 the output of iron ore attained 19,000,000 tons.

Other: There are many sedimentary manganese deposits which contain 18% to over 22% manganese. The reported output of manganese ore in 1957 was 540,000 tons.

Over 200 tin deposits are known in the country. Many of these deposits also contain tungsten, copper, lead, zinc, and molybdenum. The largest primary and placer deposits of tin are located in the provinces of Hunan, Kiangsi, and Kwangtung. The major deposits of molybdenum are of the disseminated type and are located in the provinces of Lianing, Shansi, and Kirin.

It is claimed that China occupies first place in the world in antimony reserves. The main deposits are located in three large mineralized regions spanning Hunan, Kweichow, Kwangsi, Kwangtung, and Yunnan Provinces where the content of antimony in ores varies from 1.9% to 25%. The deposits are of two types: most common are hydrothermal antimony and mercury-bearing veins; the remainder are replacement bodies of antimony-lead mineralization in limestones.

Several new copper deposits containing as much as 1.7% copper have been discovered in southwestern regions associated with carbonate rocks.

The numerous bauxite deposits have not yet been adequately explored. Beside bauxites, there are deposits of alunite and aluminous shales of Upper Paleozoic and Permo-Triassic age, which contain 35% to 72% alumina and 10% to 40% silica.

Deposits of garnierite in Inner Mongolia and the province of Yunnan are associated with an ancient zone of weathering. Cobalt is often present in these nickel deposits and is also frequently found in iron ores in amounts up to 0.8%. Chromite and titanium deposits have not been satisfactorily studied.

Great importance is ascribed to the deposits of borates in the provinces of Kirin and Liaoning. Brines of salt lakes are considered as a potential source of rare elements.

GEOLOGICAL ADMINISTRATION

The Chinese Minister of Geology, Li Sy-guan, indicates that 23,000 specialists are employed by the geological service as compared with some 200 geologists before the conquest of the country by the Communists. The engineering personnel of the service consists of 12,000 geologists and 11,000 persons graduated from vocational schools (technicums). A total 270,000 employees and workers compose the body of the Chinese geological service.

14,000 students of geology are registered in three geological institutes and in seven universities. 18,000 other students are studying in technicums. Due to the increase of geological exploration, four additional institutes will be opened soon, and the number of students will reach 30,000. Each province and autonomous region will ultimately have a geological technicum enrolling a total of 40,000 students.

In 1956 the Ministry of Geology created the All-Chinese Geological Research Institute, the All-Chinese Research Institute of Mineral Resources, the Institute of Hydrogeology and Engineering Geology, the Geophysical Research Institute, the Institute of Exploratory Technique, and the Laboratory of Geotectonophysics (Structural Geology). In addition, the Academy of Sciences has its own Geological Institute where research is concentrated on the study of genetic types of deposits, laws of distribution of mineral deposits, prospecting guides for manganese ores, and association of rare earths and radioactive elements with hydrothermal iron ores.

The Chinese geological administration acknowledges assistance from Soviet Geologists and geologists from other Communist countries working in China. Soviet methods have been widely adopted in the organization of the geological survey and the classification of ore reserves. In 1958, forty surveying parties were in the field, each party employing one or more Russian geologists. Besides making surveys, these parties were performing analyses of placers, geochemical surveys, and Geiger counter surveys.

With Soviet assistance, the first geological map of China has been completed on the scale of 1:4,000,000. Tectonic maps on the scale of 1:2,500,000 and maps of important regions on the scale of 1:1,000,000 are being prepared. Regions with known ore deposits also are being mapped on the scale of 1:200,000 and 1:50,000.

The geological service of China is aligning its work with the general party line of national industrialization. The Chinese Communist Party ordered the geological service to work "more, faster, and more economically" during the present "technical revolution". The program is to provide industry and agriculture with all necessary minerals within two or three years.

Exploration of new reserves is conducted in compliance with a program formulated by a slogan: "The entire party, the entire people are doing geological work". This is a part of the "great jump forward" which seeks to industrialize China. In some areas 70% of the population has been involved in prospecting for new mineral deposits. During 1958 the Communist administration mobilized 200,000 people in Fukien Province for prospecting service. These people discovered more than 2000 mineral occurrences including 500 iron ore deposits. The general trend is illustrated by the example of the district of Nansyan, where 30,000 people are able to determine more than ten minerals and 70, 000 people know how to use the compass, draw simple plans, and know some of the principles of ore genesis. As a result of this drive, 150,000 deposits and mineral occurrences were discovered in China during 1958. However, the geological administration admits that it was possible to check only 5% of the claims made by the non-professional prospectors.

Although geological prospecting is performed in "cooperation" with the people, the professional geologists seem not to be very enthusiastic about cooperating with these hundreds of thousands of "volunteers". This is vigorously rebuffed by the party and any criticism or opposition is qualified as a "mystical point of view", "dogmatism", "rightist conservatism", and "support of obsolete rules and limitations of the old system". Western European

and American theories and methods are traditionally criticized. In general, there is a certain feeling of anti-intellectualism in the attitude of the government despite the much advertised support of "daring thinking, daring propositions, and daring actions".

SUMMARY

An increase in the volume of work, digestion of material already on hand, and unusual conditions undoubtedly introduce much confusion. On the other hand, irrespective of the shortcomings of the system, certain progress is obvious. The government is trying to increase output at the expense of productivity, amount of labor used, and costs. This situation reminds one of the situation in Russia during the late 1920's and early 1930's, when the Soviet government started its program of industrialization. Skepticism in respect to this program inside Russia and abroad proved to be groundless. There is a difference, however, between Russia and China. At the beginning of industrialization, Russia already had some industry which had begun to develop before the revolution, in some instances faster even than during the Soviet period. China, on the other hand, had almost no industrial basis on which to start building. The program of the "great jump forward" shows that the Chinese are aiming to achieve their program of industrialization in a shorter period than has been the case in Russia.

Caution is suggested in reading articles published in the Soviet Union and China since much propaganda is added. As in the Soviet Union, there is a general trend to conceal the true reserves of strategic minerals. However, worthwhile knowledge may be acquired from these sources about the potential industrial development of these countries. It is obvious that Red China is presenting another challenge to the West, and possibly within the coming 15 to 20 years, it will become a reality as an industrial, military, and economic power.

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ALUMINA FROM SHALE?

Canadian research may point the way to economic production.

Paralleling recent experiments in the U. S., the Mines Branch of the Department of Mines and Technical Surveys in Ottawa has developed a laboratory process for recovering cell-grade alumina from aluminiferous shale. Mines Branch Research Report R45 (1959) entitled *The Alum-Amine Process For The Recovery of Alumina From Shale* by G. Thomas and T. R. Ingraham states " . . . With the recent resurgence in Canada, and in the United States, of attempts to recover cell-grade alumina from clays and shales, the Mines Branch undertook to review certain processes that had been tried with marginal success . . . In particular, it seemed quite possible that some recent developments in organic chemistry, relating to uranium technology, might be utilized for the removal of the last traces of iron from intermediate products to permit the attainment of a satisfactory grade of alumina." This introductory paragraph explains the authors' approach toward development of an alumina recovery process from shale. The following is an abstract of their successful laboratory experiments.

"The shale was baked with concentrated sulphuric acid to sulphate the aluminum, iron, and potassium constituents and to render the silica insoluble. The sulphated shale was then leached with hot mother liquor which contained potassium sulphate. When the hot liquor was cooled, potassium alum was precipitated, thus bringing about an initial separation of the aluminum from the iron.

"The potassium alum precipitate was purified either by recrystallization or by a treatment with a kerosene solution of Primene. Both of these treatments effectively reduced the level of iron contamination to the point that, when the purified alum was thermally decomposed and leached, the level of impurities in the alumina was sufficiently low for the material to meet the specifications for cell-grade alumina.

"During the leaching of the decomposed alum, the potassium sulphate added initially to the circuit was recovered, together with the potassium originally present in the shale. As a result, by-product potassium sulphate should be recoverable from this type of processing.

"The iron originally present in the shale was not recovered in a usable form. However, a major part of the sulphuric acid used initially in sulphating the shale should be recoverable from the off-gases produced during the decomposition of the alum."

TECTONIC HISTORY OF THE BASIN AND RANGE PROVINCE IN UTAH AND NEVADA

by JOHN C. OSMOND

One of the least known geologic regions in the U.S. is the area now called the Basin and Range Province. It is paradoxical that so little geologic information has been compiled for a province that has yielded billions of dollars worth of metals and is currently producing a small amount of oil. Regional stratigraphic studies of parts of this large territory have been published only recently, and regional structural interpretations of even parts of the province are rare in the literature.

This, of course, does great injustice to the earliest workers: Gilbert,[1,2] Russell,[3] Le Conte,[4] Spurr,[5] Louderback,[6] and others, who recognized the area as distinctively different from the rest of North America. Their simplified picture of the structure of the ranges and the province as a whole is the groundwork for present understanding and has never been superseded. Since their early works, however, geologic data from the province has consisted largely of detailed reports of widely scattered mining districts. Each district has been described as though it were an island in an unknown sea.

More recent syntheses of the geologic history have been prepared by Lindgren,[7] Ransome,[8] Nolan,[9] Billingsley and Locke,[10] Longwell,[11] and Eardley.[12]

J. C. OSMOND is Area Geologist, Gulf Oil Corp., Salt Lake City.
TP 48181. Manuscript, April 9, 1959. Rocky Mountain Minerals Conference, Salt Lake City, September 1958. AIME Trans., Vol. 217, 1960.

The tentative nature of the present interpretation, which treats the structural evolution of the Utah and Nevada area, must be considered in light of the scarcity of geologic information from the province as a whole. The methods of interpreting tectonic history from stratigraphy are based largely on the concepts of Marshal Kay.[13] Discussions with Hoover Mackin also have aided in organizing the Tertiary history.

TECTONIC AND STRATIGRAPHIC SETTING

Two approaches to the subject of the tectonic history are possible; they correspond to looking through opposite ends of a pair of binoculars. One involves an expansion and extension of detailed work and the other an interpretation based on regional geological relationships. It is believed that the second approach, used here, is not in disagreement with detailed observations.

The area of the Basin and Range Province is shown in Fig. 1. Within this area middle Tertiary to Recent high-angle faulting has controlled development of mountain ranges and valleys. Only the part of the area north of Las Vegas, Nev., and south of the Snake River in Idaho will be considered in this article. Within this part of the province most of the ranges trend north-south. Approximately two thirds of the area is covered by late Tertiary to Recent valley fill and lake deposits.

Fig. 1—Index map of western U. S. showing territory usually included in Basin and Range Province. In this article the Sierra Nevada is considered part of the province, and the Mohave area may not be part of it. Walker Lane, parallel to southwestern border of Nevada, shows right lateral movement and may extend into Mogollon Rim at south of Colorado Plateau. East of the province the upper Cretaceous-Tertiary overthrust belt has been subjected to post-compressional normal faulting.

Fig. 2 is a diagrammatic cross section of the Pancake Range, Railroad Valley, and Grant Range in northeastern Nye County, Nev. This cross section illustrates some of the following relationships which are typical through Nevada and western Utah:

1) Complex internal structure of the ranges, including folds, some of which are overturned; overthrusts; granitic intrusions; and high-angle faults with vertical and horizontal components of movement.

2) Asymmetry of ranges and valleys with deepest parts of valleys parallel and adjacent to the highest parts of the ranges, as would be expected in simplified titled fault blocks. These relationships are emphasized by consideration of the dips of the Tertiary volcanics and have been indicated by gravity surveys of numerous valleys from Salt Lake City to Owens Valley. A gravity profile across Railroad Valley is shown below the cross section.

3) Warm spring trends occur in valleys a few miles away from the base of ranges and parallel to them. These probably indicate major faults at depth.[14] The zone between the warm springs and the ranges may be a pediment surface covered with alluvium and fans.

Fig. 3 is a generalized map of the Pancake Range, Railroad Valley, and Grant Range showing the fault pattern, springs, and wells. The hachured lines are thrust fault traces. The others are high-angle faults with a predominant north-northeast trend, a secondary north-northwest trend, and a few east-west-trending faults.

Similar structural relationships have been recognized in many parts of the province by geologists from universities, mining and oil companies, and the USGS. The structural relationships within the valleys have been shown by gravity profiles, made for many oil companies and the USGS, and by the 35 carefully documented deep wells drilled in the province, 11 of which are in Railroad Valley near the line of the cross section. These geologic relationships are the result of a long evolution, illustrated by the accompanying series of generalized maps and cross sections.

The first stage of the structural evolution to be considered occurred during the lower part of the Paleozoic era when the area was part of the Cordilleran geosyncline, which extended from southeastern California to Alaska. This geosyncline was a broad subsiding surface on which various amounts of sediments were deposited in various depths of water. Thus it was possible that a relatively uniform blanket of several thousand feet of sediments was deposited in shallow water; the rate of subsidence and rate of deposition were in close accord. This situation predominated in the eastern part of the geosyncline.

The western part of the geosyncline was much more heterogeneous and contains both thick and thin sequences of sediments deposited in deep water,

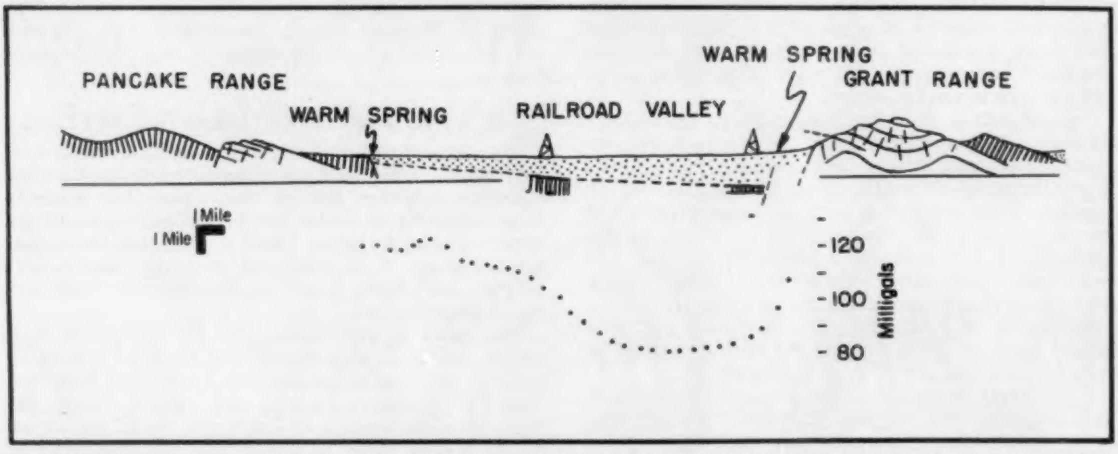

Fig. 2—Diagrammatic cross section of typical ranges and valley in the Basin and Range Province. The vertical-ruled strata are lower Tertiary volcanics and sediments resting on fractured Paleozoic rocks. The stippled space represents Miocene to Recent fill. Derrick to right is Eagle Springs oil field, and the one to the left a dry hole. The gravity profile below cross section is typical of the valleys and indicates asymmetry.

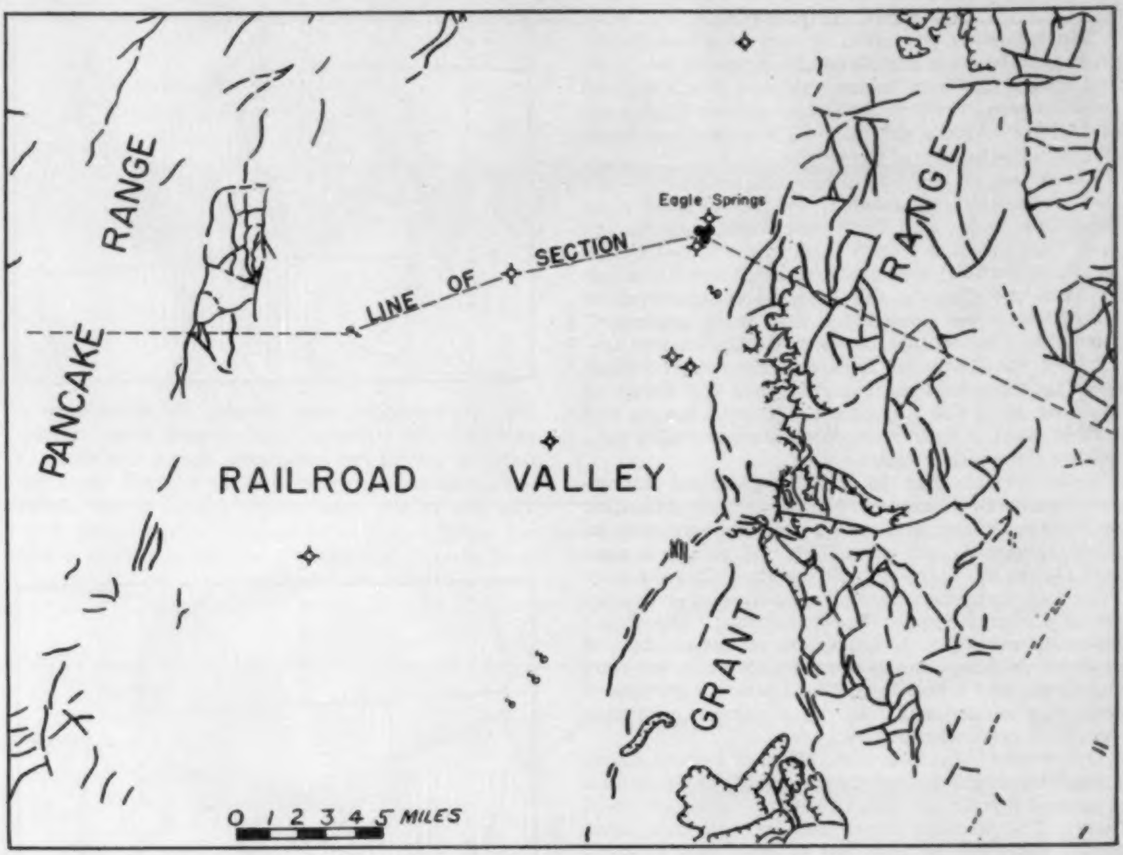

Fig. 3—Map of Railroad Valley and adjacent ranges showing fault traces, warm springs, Eagle Springs oil field (black circles) and dry holes (circle with crosses).

shallow water, and subaerial environments. Volcanic rocks and debris derived from them are common in these sediments but absent in the pre-Tertiary sediments of the eastern part of the geosyncline.

These overall differences in sedimentary materials, sedimentary environments, and sedimentary processes arise from differences in tectonic activity. The resulting rocks are distinguished as Eastern facies and Western facies. Hotz and Willden[15] first reported a transitional facies consisting of interbedded lithologies common to each of the other sequences.

Roberts et al.[16] presented a valuable summary of the changes in the Paleozoic rocks from the region of Eastern (assemblage) facies to that of the Western facies. The transitional facies of the Cambrian to Devonian systems appear to indicate that a barrier did not separate the Eastern and Western facies.

Similarly, the changes in location of various types of sediments and thicknesses of sediments reflect changes in tectonic activity. The sequence of maps and cross sections presented here illustrate, in a general way, the stratigraphic changes and the tectonic changes which caused them.

Three more points will be helpful in visualizing this interpretation. First, major vertical movements will be considered relative to adjacent tracts of the crust. Thus the geosyncline may subside (be negative) relative to the more stable central part of the continent (craton), which may lie below sea level and be receiving thin marine deposits. Also, parts of the geosyncline may become positive relative to adjacent parts of the geosyncline, but these positive areas may remain below sea level and receive thin marine deposits. The relative vertical movements also can be reflected in nonmarine deposits (continental or lacustrine).

The second point concerns the third dimension of the cross sections, which were constructed along lines from northeastern Utah to central Nevada and thence to northern California. Individual depressions and positive areas shown probably vary to the north or south of these lines, but the overall relations remain the same.

The third point in this preface is the designation of the term *welt*[17] to the elongate positive area that rose between the areas of Eastern facies and Western facies and expanded laterally during Paleozoic and Mesozoic time. This uplifted belt is similar to Haarmann's "geotumor,"[18] Wolfe's "blister,"[19] Rich's "magma body" (Ref. 20, Figs. 1 and 2), and Le Conte's arch lifted by "intumescent lava" (1889).[4] Probably it was not always above sea level for its entire length until Mesozoic, and even then it contained local structural depressions which received several thousand feet of nonmarine sediments.

The terms *Manhattan geanticline, Antler organic belt, Mesocordilleran geanticline,* and *Sevier Arch* have been applied to parts of this welt at various stages during its development. As the term *geanticline* has been used previously with different connotations, *welt* seems more descriptive and is used here.

TECTONIC SEQUENCE

The following discusion of tectonics and stratigraphy of the Utah and Nevada segment of the Basin and Range Province begins with the Cambrian and includes each period to the Recent. Generalized maps and east-west cross sections will illustrate significant stages in the history of the region.

Cambrian: During Cambrian time eastern Nevada and western Utah subsided, and up to 8000 ft of sandstone, shale, and carbonate rocks were deposited. This system is 5000 ft thick in the Wasatch Mts. and thins abruptly east of the Wasatch line.[18] In much of Utah and Nevada the basal sandstone overlies with little or no discordance very thick sections of quartzite. The contact between Cambrian and undoubted Pre-Cambrian is rarely exposed. The limestone unit becomes more argillaceous and cherty to the west as in the Toquima and Toyabe ranges and farther west is equivalent to calcareous shales containing some pillow-lavas.

Roberts et al. (Ref. 16, p. 2828) describes the upper Cambrian Harmony formation as feldspathic sandstone, arkose, and grit with minor amounts of shale, limestone, and chert. This unit occurs in several ranges in north-central Nevada and is the only Paleozoic formation bearing evidence of a nearby granitic source (upper Pre-Cambrian). The Cambrian appears to be divisible into an eastern belt of uniform thickness, between central Nevada and central Utah, and a belt to the west which commenced subsiding earlier and received a generally thicker deposit of more siliceous sediments.

Ordovician: Fig. 4 shows the belt of eastern facies (stippled) and the transitional zone (*T*) which separates it from the belt of western facies (vertical lines). The western facies subsequently has been thrust eastward so that the original relationships have not been preserved. However, because of interbedding of eastern facies limestone and western facies graptolitic shale, the same marine waters probably had access to each depositional area.

Fig. 5 is a reconstructed cross section showing the abruptness of the eastern margin at the hinge line (*H*) with the craton to the east. The eastern facies is predominantly shallow water carbonate deposits (Pogonip, Garden City, and Fish Haven formations) with a medial clean quartzite (Eureka, Swan Peak, and Kinnikinnic formations) that was derived from the east. The western facies, up to 25,000 ft thick, is predominantly black silty shale with graptolites, thick sandstones similar to the Eureka, bedded chert, and volcanics (Vinnini and Valmy formations).

Silurian: The Silurian deposits are thinner than those of the other periods; however, they also have an eastern facies of dolomite (Laketown and Lone Mt. formations) and a western facies of graptolitic shale, sandstone, and silty limestone. Silurian shallow water fossiliferous limestone is present in the Klamath region of northern California. Winterer and Murphy[21] have suggested that the 4500 ft of Silurian dolomites trending north through the Roberts Mts., Nev., represent a reef with deeper water reef-flank and off-reef deposits to the west. This reef trend corresponds to the zone separating the compartments of the Cordilleran geosyncline.

Devonian: The eastern facies of the Devonian (Sevy, Simonson, Nevada, Devils Gate, Jefferson, and Water Canyon formations) is predominantly carbonate rocks; the western facies consists of chert, shale, and local silicic pyroclastics in western Nevada, volcanics in the Klamath region, and argillite, chert, marble, and basalt in northwestern California.

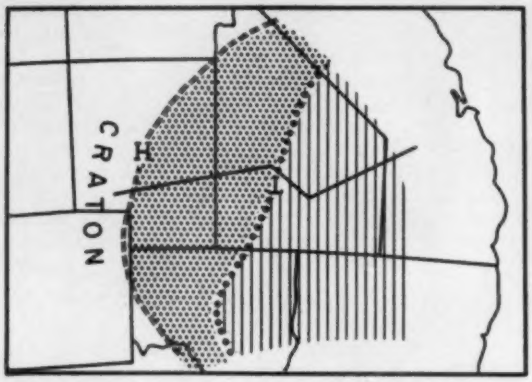

Fig. 4—Generalized map showing the distribution of eastern facies (stippled) and western facies (vertical rules) in Cordilleran geosyncline during Ordovician. T is the transition zone and H is the Wasatch hinge line. The line of the cross section Fig. 5 is also shown.

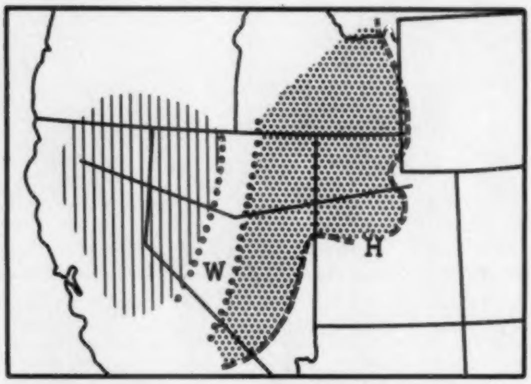

Fig. 6—Generalized map of part of the Cordilleran geosyncline during the Mississippian age. W denotes the rising welt and H is the eastern margin of the geosyncline. Line of the cross section Fig. 7 is also shown.

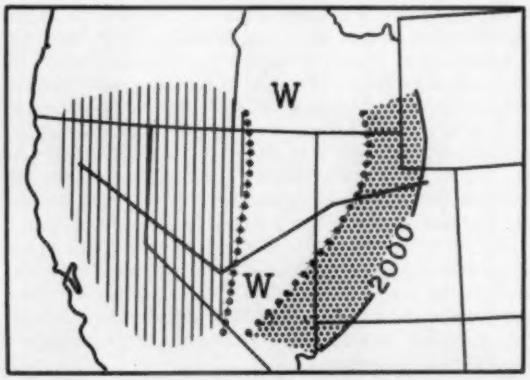

Fig. 8—Generalized map of Utah-Nevada during late Triassic showing eastward expansion of welt, W, with adjacent subsiding areas. Triassic deposits are more than 2000 ft thick and partly mature between 2000-ft line and welt. East of 2000-ft line deposits are thinner and almost entirely nonmarine. Line of the cross section Fig. 9 is shown.

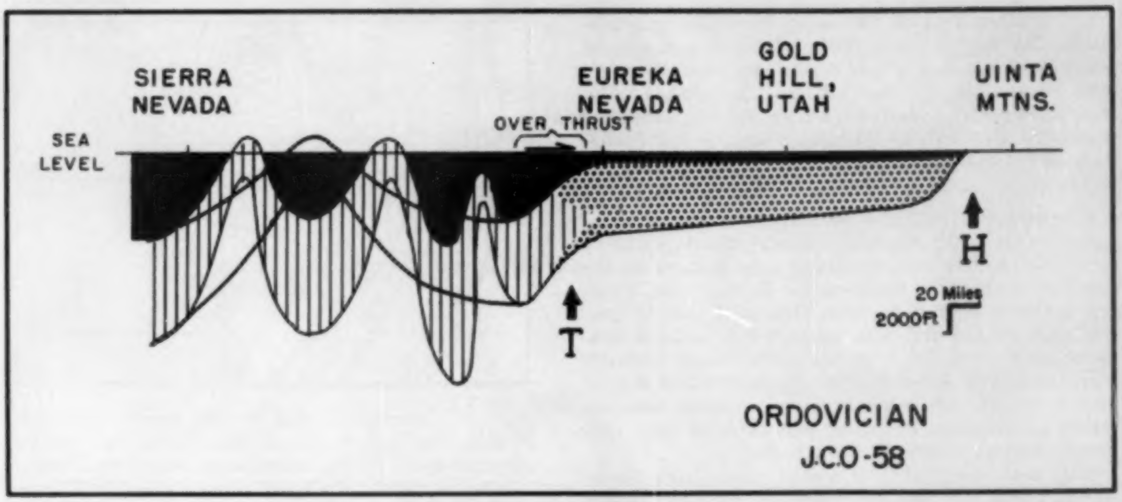

Fig. 5—Diagrammatic cross section across cordilleran geosyncline during Ordovician. Patterns as on Fig. 4. Solid black space designates water. H is Wasatch line hinge separating Craton on east from geosyncline; T is the transitional zone of increased slope of the sea floor separating the eastern and western compartments of the geosyncline. The variability of profile along the trend is indicated by the possible interpretation of one island north or south of the cross-section.

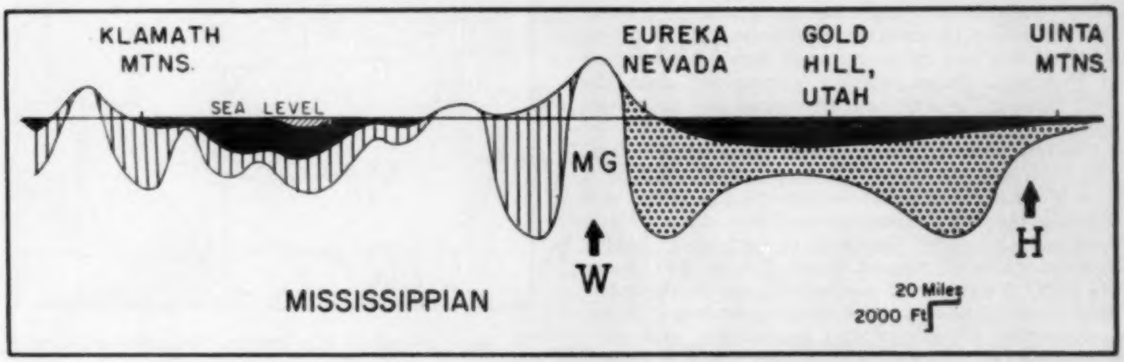

Fig. 7—Cross section, Cordilleran geosyncline, during Mississippian age. MG, Manhattan Geanticline phase of welt.

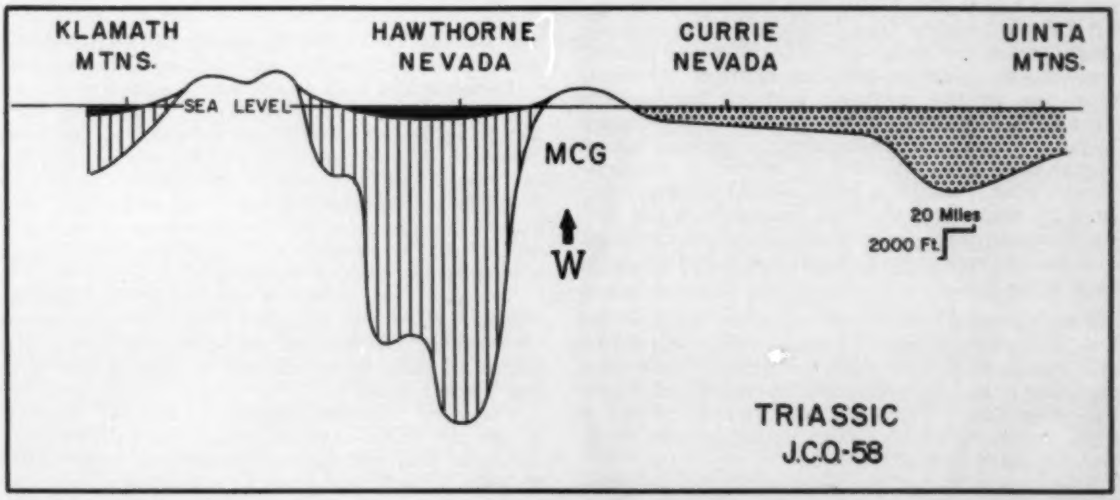

Fig. 9—Diagrammatic cross section of Utah-Nevada during the Triassic time showing the Mesocordilleran Geanticline (MCG) phase of welt. Only the lower Triassic is present between the welt and the thick Triassic section near the Uinta Mts. The sea regressed from the area east of the welt during the Triassic period.

Toward the end of Devonian time the zone between the Eastern and Western facies commenced positive tendencies which continued into Mississippian time (Ref. 22; Ref. 16, pp. 2835-2854). Also an area in northwestern Utah rose and was subjected to erosion. Parts of the Wasatch, Oquirrh, and Stansbury ranges (Ref. 23, p. 146; Ref. 24, pp. 83-88) are on the arch.

Mississippian: Figs. 6 and 7 show the zone of uplift (welt = *W*), known as the Manhattan geanticline and Antler orogenic belt, which grew in the position of the zone between the Eastern and Western facies of earlier periods. This welt rose to considerable height and was subjected to intense erosion. Large areas of it slid or were thrust to lower elevations. The Roberts Mts. overthrust and related major thrusts in central Nevada moved western facies as much as 80 miles eastward so they now overlie eastern facies (Ref. 16, p. 2851).

This is the beginning of a welt which grew laterally and now includes the Basin and Range Province. The welt was very heterogeneous in that parts of it rose or subsided to varying extents at different times and were eroded to different depths. Probably there were several orogenic pulsations separated by periods of slower readjustments. Roberts et al. (Ref. 16, pp. 2838-2846) discuss the "overlap assemblage," which consists of conglomerate, sandstone, shale, and limestone in variable thicknesses up to a few hundred feet and ranging in age from Mississippian to Permian. These deposits overlapped onto the west flank of the welt as it decreased in height during late Paleozoic time.

Clastics eroded from the welt were deposited in subsiding depressions to the east and west of it as well as in several depressions on it. To the east the deposits are predominantly black shale (White Pine and Chainman formations) with chert pebble conglomerates (Diamond Peak formation) nearer the uplift. To the west the deposits are cherty argillite, shale, limestone, greenstone, andesitic flows, pyroclastics, orthoquartzite, graywacke, and conglomerate. In the Klamath region there are local coral reefs with cherty shale, tuff, and conglomerate probably associated with islands.

The eastern part of the geosyncline was broken into two basins, the White Pine Basin near the uplift and the incipient Oquirrh Basin near the eastern boundary of the geosyncline. Decker[25] and Steele[26] proposed an eastward-trending uplift of Mississippian age in the northern part of northeastern Nevada. Steele cites evidence from northeastern Nevada of some north-trending anticlines whose higher parts were removed by erosion in Pennsylvanian time. Possibly a large similar structure existed in western Utah. This break-up of the formerly homogeneous segment of the crust continued into the Pennsylvanian and resulted in further additions to the welt.

Pennsylvanian: The welt remained positive but was lowered by erosion. Its western edge foundered, and Pennsylvanian deposits onlapped it and were deposited in several basins upon it (Battle and Highway formations). The Havallah formation, 10,000 ft thick, consisting of sandstone, limestone, and shale, was deposited west of the welt.

The eastern part of the geosyncline and the edge of the craton continued to break up with development of the Oquirrh and Paradox basins and adjacent uplifts. Cyclic marine limestones, shales, and siltstones were deposited in western Utah and eastern Nevada. Dott (Ref. 27, pp. 11-13) discussed the tectonic and sedimentary environment of this system.

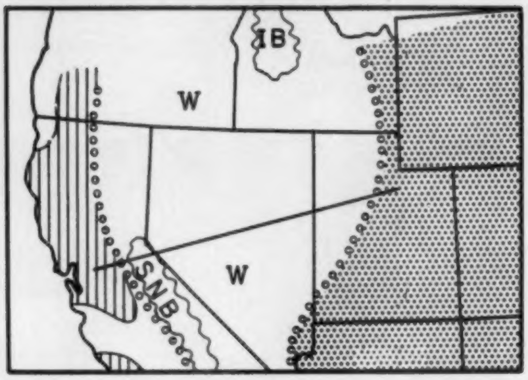

Fig. 10—Generalized map of the upper Cretaceous showing the welt W (blank area), Rocky Mt. geosyncline (stippled). Pacific Coast geosyncline (vertical rules), and Sierra Nevada (SNB) and Idaho batholith (IB) within the welt. Line of the cross section Fig. 11 is also shown.

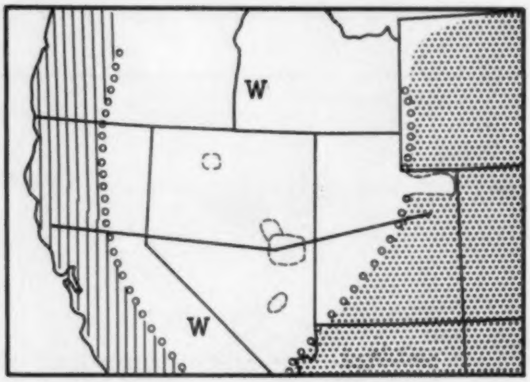

Fig. 12—Generalized map showing the extent of the welt during lower Teritiary and location of sediments of this age preserved in structural depressions on the welt. They probably also are present in several other places. The line of the cross section Fig. 13 is also shown.

Permian: The welt was probably eroded quite low but remained an effective barrier separating very thick deposits of clastics and volcanics on the west from red-bed, evaporite, and carbonate deposits locally very thick in eastern Nevada. Deposition of siliceous and phosphatic sediments east of the welt may have been influenced by the abundance of volcanics to the west. Roberts et al.[16] report Permian folding and thrusting west of the welt.

Triassic: Figs. 8 and 9 show that the western margin of the welt subsided, and a thick sequence of volcanic, clastic, and carbonate sediments was deposited there in an unstable tectonic setting during Triassic time.[28]

The area eastward almost to the old Wasatch hinge line was consolidated with the welt, forming a larger area wth positive tendencies after lower Triassic time.[29] The zone of subsidence migrated eastward approximately to the position of the former hinge line.

This depression was probably asymmetric, the steeper side toward the west. The abrupt eastward

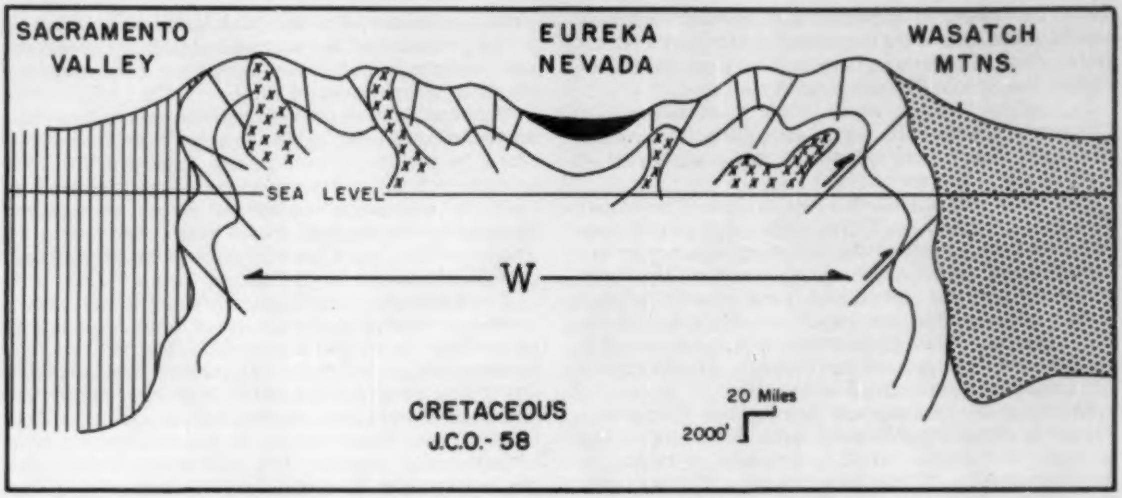

Fig. 11—Cross section of the welt during the Cretaaceous period. Patterns here as on Fig. 10. The solid black area represents the Cretaceous deposits near Eureka, Nev., and the crosses indicate granite intrusions.

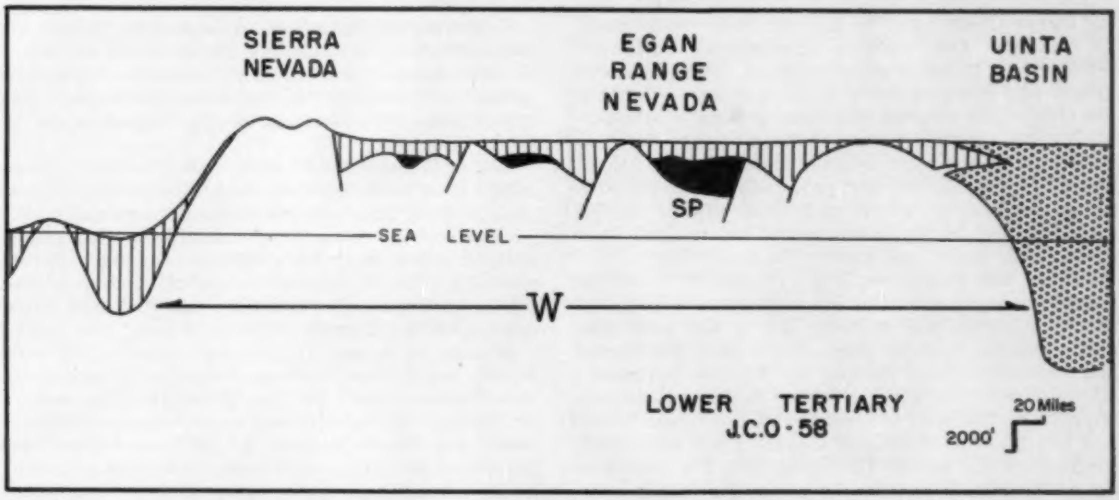

Fig. 13—Diagrammatic cross section of welt following deposition of volcanic blanket. The solid black areas represent the lower Tertiary deposits on top of welt. To the east is the Uinta Basin and to the west the Pacific Coast deposits.

thinning from the geosyncline onto the craton which persisted through the Paleozoic was replaced by gentle thinning over a westward epeirogenic tilting of the western edge of the craton. The 2000-ft isopachous line for the Triassic period is shown in Fig. 8.

Ultrabasic rocks were intruded along a zone through central California and central Oregon during the Triassic and Jurassic periods.

The Triassic presents the first break in the symmetry of the North American continent which was produced by the similarity of the Cordilleran and Appalachian geosynclines since Pre-Cambrian time. The differences in history of these two areas during Mesozoic and lower Tertiary time account for the presence of the Basin and Range structures in Utah and Nevada and the lack of similar structures in the Appalachian region.

Jurassic: During Jurassic time the welt expanded westward from central Nevada to central California as shown on the series of isopach maps by McKee et al.[**] Ferguson and Muller[**] record compressional tectonics associated with uplift of the western part of the welt. Flanking the western edge of the welt 10,000 to 20,000 ft of sediments were deposited in a complimentary depression.

A similar depression along the eastern margin of the welt from southeastern Idaho to southern Nevada received more than 5000 ft of sediments. Part of these deposits was destroyed by subsequent eastward expansion of the welt. This trough was along the trend of the former Wasatch hinge line and was asymmetric with a steep flank to the west and a gentle flank to the east.

Cretaceous: Figs. 10 and 11 show the welt to have been consolidated as a positive region from central Utah to central California. The eastern margin rose to form the Sevier Arch,[**] which shed clastics into the Rocky Mt. geosyncline on the western margin of the craton.

Along the western edge of the welt, approximately in the position of the Great Valley of California,

the crust subsided greatly, and several thousand feet of sediments were deposited in the Pacific Coast geosyncline. These were derived in part from erosion of the Sierra Nevada part of the welt.

In central Nevada about 1000 ft of nonmarine Cretaceous sediments were deposited in a small structural depression indicating the irregularity of the surface of the welt.

The welt was intruded early in Late Cretaceous time by granitic rocks.[illegible] This material probably was released from a part of the subcrust which was expanding and causing the enlargement of the welt. These synorogenic intrusions were closely related to deformation that continued into Paleocene time and included folding, overthrusting, and possible gravitational gliding of large sheets of sediments. The folds trend generally north-south.

Evidence of deformation during the Cretaceous Period is given by Willden,[illegible] who reports Jurassic or early Cretaceous uplift and diorite intrusion in the Jackson Mts., 50 miles northwest of Winnemucca, Nev. Lower Cretaceous rocks in this range were tightly folded during Cretaceous or early Tertiary time, conglomerates were deposited across them, and older rocks were thrust over them.

The welt reached its maximum development during upper Cretaceous, as did the depressions along its east and west margins. Intensity of tangential deformation, possibly compressional, reached a maximum, and synorogenic granitic intrusions invaded the crust. This orogeny is known generally as *Laramide,* and compressional mountains were formed. The crust of the welt became oronized (Ref. 34, p. 504). That is, the former geosyncline and its contained sediments, which had been pliable in the Paleozoic and Mesozoic periods of deformation, became consolidated and more rigid and brittle.

Eocene and Oligocene: Figs. 12 and 13 show the maximum areal extent of the welt when it included the region from the Wasatch Mts. to the west side of the Sierra Nevada. East of the welt the Rocky Mt. geosyncline was broken up into several basins and mountain ranges; however, major subsidence adjacent to the welt is recorded in the Green River and Uinta basins and along a narrow belt extending southwestward across Utah and into the southern tip of Nevada. Numerous basins in California were on the west side of the welt.

On top of the welt alluvial and lacustrine sediments of Eocene age were deposited in structural depressions and are preserved in a small area south and southwest of Ely (Winfrey's Sheep Pass formation)[illegible] and north of the Narrows of the White River near Hiko (Fig. 12). The Sheep Pass formation, consisting of locally derived conglomerate, sandstone, shale, and limestone, was deposited in an elongate depression bounded by east-west faults. Probably similar rocks are present but unrecognized in several other places in western Utah and Nevada. Active erosion during this time lowered the relief of the compressional mountains.

Following deposition of the Eocene sediments an extensive blanket of volcanic rocks was deposited over the region. The age of these volcanic rocks is probably Oligocene, although some may be lower Miocene in age and others upper Eocene, depending on the geochemical, paleontologic, or stratigraphic method used in the age determination. These rocks have been described as welded tuffs,[illegible] ignimbrites,[illegible] latite flows, and rhyolite flows. Extrusive volcanic rocks of these types and of similar ages are present throughout most of the area of western Utah, Nevada, and eastern California. A significant exception is in northeastern Nevada where tuffaceous alluvial and lacustrine sediments including limestone and oil shale were deposited.

The stratification of these volcanics was essentially horizontal and is probably the most important datum plane in the Basin and Range Province. This sequence, with an estimated average thickness of 1500 ft, represents 60,000 cu miles of material brought to the surface. These rocks were deposited unconformably on a surface with relief greater than their thickness.

These volcanic rocks apparently came from widely scattered sources and because of their high degree of mobility filled the topographic low areas on an uneven but essentially horizontal surface. (Mackin has prepared a manuscript discussing these rocks and their tectonic significance.) The tuffs and flows probably represent transfer to the surface of a layer of subcrustal molten rock with about the same thickness, 1500 ft. Some faulting and tilting was coincident with this deposition; however, the greatest part of the faulting which created the present ranges and valleys is later than these volcanics, which rest on the more gentle *dip-slopes* of the tilted fault blocks.

Following deposition of at least part, if not all, of these extrusive rocks, they were locally deformed by intrusions of post-orogenic granitic stocks and laccoliths in western Utah and eastern Nevada. The age of these intrusives is probably Oligocene and/or lower Miocene.

The welt maintained much of its Cretaceous magnitude into lower Tertiary time. The transfer of vast quantities of post-orogenic volcanic material to the surface and the intrusion of numerous post-orogenic granitic stocks may have initiated a brief regional lowering of the surface of the welt which was probably in part counterbalanced by the thickness of the deposits on the surface.

Miocene to Recent: The geologic history of Nevada during the Cenozoic era has been summarized by Van Houten (Ref. 38, pp. 2819-22). The surface of the welt during Miocene time was about 2000 ft above sea level (Ref. 39, p. 1527) and contained "scattered mountains and many lakes and swamps." Local volcanic sources contributed flows and widespread, very abundant effusives.

Miocene and Pliocene sediments are generally tuffaceous and consist of alluvial clastics derived from nearby mountains and lacustrine calcareous very fine clastics containing ostracods, diatoms, and carbonaceous material. These rocks reach 7000 ft in thickness and pass imperceptibly upward into modern *valley fill.* Conglomerates are present only in a narrow zone adjacent to the ranges and pass rapidly into silt and clay-size clastics.

Basaltic and andesitic flows of the Columbia River Plateau overlapped the northwestern part of the welt in southern Oregon and northern Nevada during Miocene time.

The region from the west side of the Sierra Nevada to the high plains east of the Rocky Mts. rose during Pliocene to Recent time. High-angle faults developed as a result of this extension of the crust and are especially evident in the Basin and Range Province on top of the welt. The valleys and ranges of this province were formed by movement along these faults that probably began in Miocene time and continued to Recent (Basin and Range orogeny). The greatest movement probably occurred in Pliocene time.

The region characterized by this block faulting is the Basin and Range Province, and in Utah, Idaho, Nevada, Oregon, and California it coincides with the extent of the welt. Similar Cenozoic block faulting occurred in Arizona, New Mexico, Texas, and Mexico, but the history of that area is different from the one described here.

In Utah and Nevada the ranges trend north-south. Some contain complex internal structures produced during previous deformations, whereas others contain broad gentle middle Tertiary folds.

The range fronts are irregular, with cove-like re-entrants, prominences (*points*) extending into the valleys, and straight segments parallel to the trend of the ranges. Despite these variations, the range fronts are remarkably straight on large-scale maps. The range-front faults are composites of several faults. Some of the ranges appear to have been uplifted along one or both sets of fractures (*faults*) developed by a shear couple. These faults trend north-northeast and north-northwest, and when uplift occurred along alternate sets every few miles, a serate mountain front is formed. Some of the ranges appear to have been uplifted predominantly along one set of shear fractures, and the result is an *en echelon* series of ramp-like segments of the range. The straight segments of some range fronts may be the results of uplift along faults which formed as longitudinal faults on folds created during Cretaceous or Mississippian times. The uplift of the ranges was accomplished in the easiest of several available ways.

As the ranges grew, each valley was filled with debris by its own interior drainage system. As the valleys filled and the divides were covered, these systems coalesced, until about the time of Pleistocene glaciation two large lakes, Bonneville and Lahontan, were formed. Glaciers were present in the Wasatch Range, Ruby Range in Nevada, Sierra Nevada, and other high ranges throughout the province.

The interior drainage system in western Utah and Nevada persists as the Great Basin, a term with only hydrographic significance, but it is being encroached by exterior drainage from the Colorado and Snake River systems.

The province has returned to arid conditions, and degradation of the mountains is now caused mainly by small sporadic floods carrying debris down the canyons to form alluvial fans. Many of the valleys contain playas.

Recent tectonic activity in the province is expressed in the form of earthquakes and small dislocations of the surface. Recent volcanic activity has resulted in small outpourings of basalt.

The Snake River downwarp extends from east to west across southern Idaho. It is filled with the many thousands of feet of Pliocene and Pleistocene basalt flows, which filled the depression as it sank. Ranges and valleys of the Basin and Range Province plunge beneath the basalts and reappear north of the downwarp. Some of the ranges terminate abruptly as though cut off by large faults. Many of these basalts post-date the major uplift of the ranges. The downwarp is strikingly transverse to earlier structural grain.

MECHANICS OF BASIN AND RANGE TYPES OF BLOCK FAULTING

The mountain ranges and valleys of western Utah are considered typical of the Basin and Range Province (Fig. 1). Similar tilted fault block ranges have been recognized to the north in southern Oregon, Idaho, and western Montana and to the south in Arizona, New Mexico, Texas, and Mexico. Some of the similarity may be more the result of physiographic features than structural ones. Although all these ranges appear to have been caused by vertical forces acting since mid-Tertiary, the geologic histories of these various areas are quite different up to the beginning of Tertiary time. Therefore the following discussion is applied here only to that part of the province in Utah and Nevada.

Several theories have been suggested to explain the development of the ranges and valleys of the province. These can be grouped into two general classes: 1) those predicated on regional tension and 2) those predicated on regional compression. Nolan (Ref. 9, pp. 178-179) has summarized the ideas presented before 1939. The following discussion will

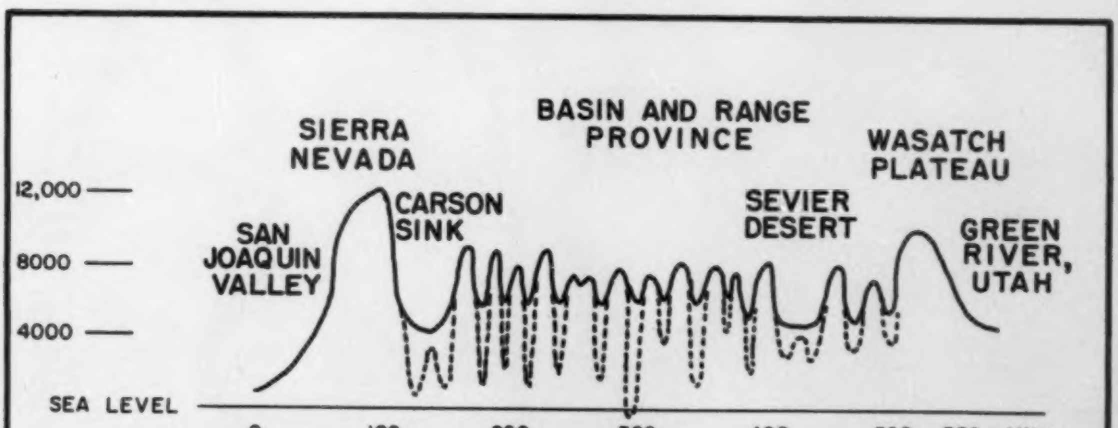

Fig. 14—Depths to pre-middle Tertiary rocks in the valleys, San Joaquin Valley to Green River.

include recent observations pertinent to these theories and also the theories that have been presented since 1939.

Tensional Causes: The first widely accepted explanation of the ranges of the province was presented by Gilbert in 1875 and was reiterated in 1928. Gilbert called attention to the large normal faults on one or both sides of most of the ranges in western Utah and Nevada and attributed these faults to vertical (tensional) forces. The possibility of tension in surficial rocks arched over a rolling surface below the crust was mentioned, but the cause of the vertical forces was not thoroughly discussed.

Gilbert's ideas have been accepted by the majority of geologists working in the region; other geologists have suggested modifications, and some have disagreed completely with his ideas. The basic concept of vertical movement, not horizontal forces, creating the ranges remains the logical explanation.

LeConte[4] proposed that the tilted fault-block ranges resulted from distension of the crust in an arch lifted by "intumescent lava." The abundant volcanism and intrusion prior to the block faulting and the waning volcanism since it began appear to contradict the cause of the arch LeConte proposed.

Most of the Basin and Range Province is more than 5000 ft above sea level, with numerous ranges rising to elevations over 9000 ft. Near the eastern and western margins of the province are broad areas 4000 to 5000 ft above sea level. These slight depressions near the margins are adjacent to the 8000 to 12,000-ft elevations of the Sierra Nevada in California and the easternmost ranges of the province and the high plateaus of Utah (Fig. 14).

The province appears as a broad topographic high area in eastern Nevada with peripheral topographic depressions. These, in turn, are flanked on the east and west by narrow belts of elevations higher than those in the center.

The western part of the U. S., from the Great Plains to California, has been elevated about 2000 to 5000 ft since Miocene time.

Evidence of regional uplift of the province is found in the fact that upper Cretaceous rocks which were deposited near sea level adjacent to the welt from southeastern Idaho to southern Nevada are now more than 5000 ft above sea level. Similarly, Mio-Pliocene sediments deposited about 2000 ft above sea level in western Nevada[30] are now more than 5000 ft above sea level.

Many of the mountain peaks in the province are more than 9000 ft above sea level. The valleys contain a large volume of debris that has been eroded from them as they rose. The deepest parts of many of

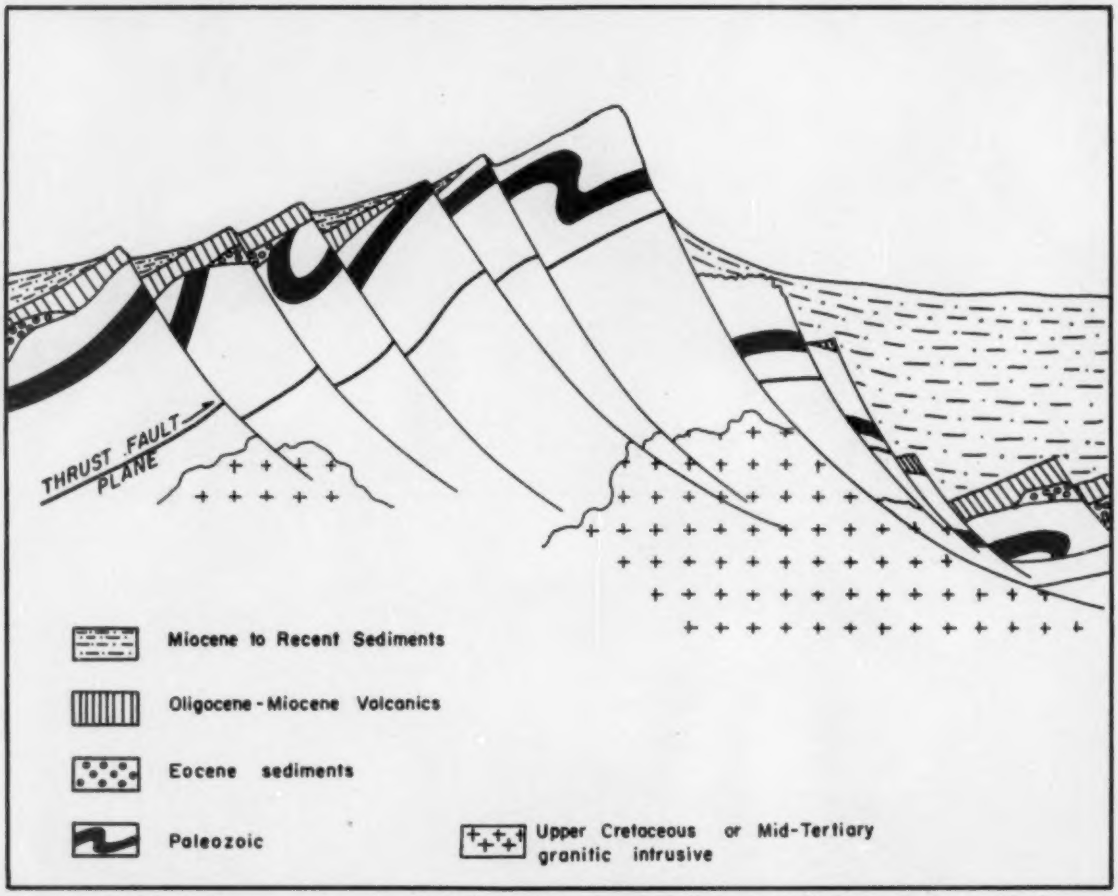

Fig. 15—Hypothetical cross section of a typical mountain range in the Basin and Range Province. Much spatial adjustment is taken up by small movement along abundant fractures and antithetic faults. Blocks downthrown toward the valleys, as to the right of the crest here, may protrude through the gravels as small hills or may have pediment surfaces cut on their tops. Similar though more deformed cross sections may be drawn through parts of ranges where granitic stocks have been intruded. Range profiles are altered from that above by erosion and also by a greater number of faults.

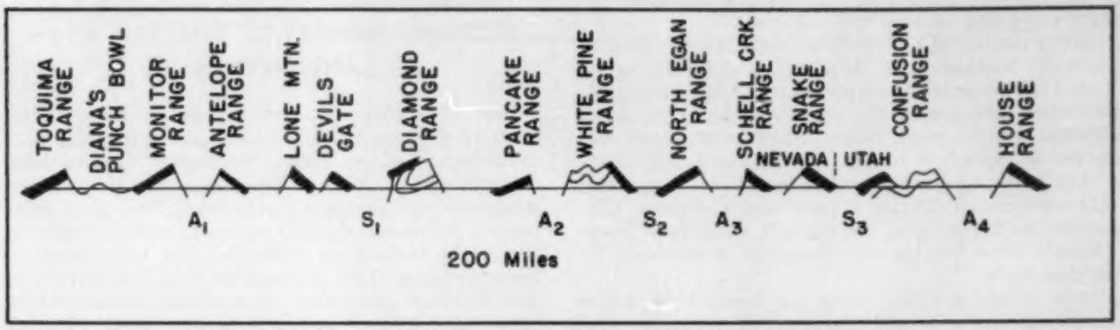

Fig. 16—Diagrammatic cross section from the Toquima Range in central Nevada to the House Range in Western Utah The solid black bands which represent lower Tertiary volcanic deposits show the dip slopes of the ranges. The ranges can be interpreted as being the remnants of four large anticlinal structures (A) with intervening synclines (S).

the valleys are about sea level. This would indicate that the Oligocene (?) volcanic surface has an average elevation of 5000 ft, which is probably more than 3000 ft above its elevation at the time of its deposition.

That the actual uplift of the ranges has been more than that of the valleys is indicated by the absence of the Oligocene (?) volcanics from many peaks over 10,000 ft above sea level and the presence of Mio-Pliocene sediments at elevations over 7000 ft, well above the valley floors, in many mountain passes.

The normal faults probably approach horizontal at depths of less than 5000 ft below sea level, or they may end at possibly greater depth if there is a regional surface of slippage (Fig. 15).

Abundant small antithetic faults are important in fitting the blocks to their new shapes and positions. It is possible that adjustment along these faults and fractures is adequate to compensate for all the movement on the major normal fault system.

This epeirogenic rise meant that the crust of this area had to adjust gravitationally to the greater length of the arc of its segment of the earth. This adjustment took place in the Basin and Range Province by differential uplift along normal faults which dip about 70°. The ranges are typically tilted fault blocks made up of several essentially parallel blocks tilted in the same direction and upthrown on the same side but usually in lesser amounts than the main range front. This tilted stair-step configuration continues beneath the valleys, forming tilted graben whose greatest depth is adjacent to the next mountain range. The zones from the deepest part of the valleys to the crests of the ranges is about 3 miles wide and usually consists of stair-step fault slivers respectively upthrown toward the ranges.

The ranges, evenly spaced across the province, are 6 to 15 miles wide and often more than 100 miles long.

Fig. 16 is a diagrammatic cross section from the Toquima Range in central Nevada to the House Range in western Utah. The direction of tilting of the fault blocks is indicated by the dip of the Oligocene (?) volcanics, which are assumed to have had nearly horizontal upper surfaces when deposited.

This cross section can be interpreted as representing tilted fault blocks developed by tension over four large deep anticlines or as more or less random tilting resulting from province-wide uplift. Evidence favors the latter except between the Monitor and Antelope ranges. These ranges appear to join at the south, forming a south-plunging anticline, the valley having been formed by down-dropping of a keystone block.

If the ranges had been formed over large deep anticlines, the elevations of the crests might be expected to increase toward the axial planes of the proposed anticlines or older strata should be exposed at higher elevations nearer the axial planes. These conditions are not observed.

If such deep anticlines existed and were leveled by collapse, there should have been concurrent leveling of the intervening synclines which would have created compressional mountains.

Further difficulty with the deep anticline theory is presented in the Egan Range. North of Ely, Nev., the range dips to the west for 60 miles. From Ely to a point 70 miles south it dips east and there changes to west dip for several miles more along the same strike. Unless these segments have been coincidently moved laterally to their present inline position, they cannot be explained as associated with a large deep anticline.

Many other geologists, including Longwell (1950),[11] have considered that the normal faults resulted from the collapse of an arch following subcrustal transfer of igneous material. This has been explained as resulting in transfer of the Tertiary volcanics to the surface of the Basin and Range Province or laterally eastward to cause the uplift of the Rocky Mt. Province.

Removal of subcrustal material would have induced horizontal compression in the crust as it attempted to adjust to its shortened arc. The range-bounding faults are generally recognized to be normal faults, and post-lower Tertiary compression does not appear to have been an active regional force.

Axelrod has cited paleobotanical evidence from western Nevada that indicates the province has been elevated since mid-Tertiary. R. Y. Anderson examined subsurface samples of Mio-Pliocene sediments from eastern Nevada for the Gulf Oil Corp. in 1955 and concluded from a study of the spores and pollen that the ranges contained flora similar to those of today. In neither case is there evidence of general subsidence of the area but rather indications of uplift of the ranges and valleys.

Compressional Causes: Many theories have been presented citing regional tangential compression as the cause of the present ranges and valleys of the province. The first of these theories presumed a similarity of the Basin and Range Province with the compressional-erosional mountains of the Appalachian Province. The structural similarity was soon found not to exist, but Spurr (1901)[8] and

Keyes (1908)[40] continued to propose erosional processes as having created the valleys.

Baker suggested that some of the ranges in southwestern Nevada and adjacent California were caused by tangential compression.[41] Other geologists also have interpreted the ranges as resulting from regional compression. Some have interpreted the ranges as upthrust blocks and others have interpreted them as Tertiary anticlines involving rocks deformed before Tertiary time and therefore discordant to the form of the present anticlines. These concepts have not been documented extensively in the literature.

Most recent workers have not favored the compressional or erosional theories for creating the ranges and valleys. However, Steele[30] has presented a very interesting new theory which combines certain aspects of both ideas.

Steele proposed a history of development as follows:

1) Mississipian orogeny created the northeast-southeast-trending Manhattan geanticline in central Nevada and east-west-trending positive feature in northern Elko County (northeastern), Nevada.

2) East of the geanticline the shelf area (eastern Nevada and western Utah) was gently folded into north-south-trending folds.

3) Upper Mississippian and lower Pennsylvanian erosion breached and beveled the anticlines, some as deeply as the middle Ordivician quartzites, and filled the synclines with clastics.

4) Oscillatory uplift and subsidence of the folded area allowed mixing of clastics from the geanticline and positive area in marine sediments during upper Pennsylvanian, Permian, and lower Triassic time.

5) Post-middle Miocene major compressive forces acted in an east-west direction. The buried eroded anticlines acted as the jaws of a vice on the thicker, weaker Paleozoic sedimentary piles within the synclines, which were forced topographically higher than the anticlines, with major shearing along the flanks. Some of the ranges are horsts bound by reverse faults and others have been gently arched.

In summary, in northeastern Nevada, present ranges were born from thick sedimentary sections once protected in the synclines, while the valleys have been formed from eroded anticlines stripped of their middle and lower Paleozoic cover and subsequently buried by Tertiary valley fill.

The compressional forces which have caused lateral movement along the San Andreas fault in California are considered to have created Basin and Range structure. Cloos (Ref. 42, pp. 246-247, 254-255, and Fig. 8) has experimentally reproduced some Basin and Range structures by lateral extension of blocks of clay and has reproduced some of the map patterns by rotation of a shear couple.

Moody and Hill (Ref. 43, pp. 1221-1223) have interpreted the ranges and valleys of the province as the results of shear caused by north-south compression. This is considered part of a universal system of wrench-fault tectonics. Their statements regarding uppermost Tertiary compression and overthrusting are undocumented; however, the basic concept is worthy of consideration because of the evidence of several large wrench faults within the province and lateral movement along recent earthquake scars.

RELATIONSHIP OF ORE DEPOSITS TO TECTONIC HISTORY IN WESTERN UTAH AND NEVADA

Fig. 17 shows the distribution of mining districts in western Utah, Nevada, and part of California as compiled by Jerome and Cook.[44] Most of these deposits are in the vicinity of Mesozoic or Tertiary intrusions or Tertiary extrusives. The area containing these ore deposits coincides with the area of the Basin and Range Province, and the history of these deposits is an integral part of the history of the province. Ferguson[45] recognized three general types of districts: 1) the ones associated with intrusives related to those of the Sierra Nevada, typically argentiferous quartz vein deposits in the western half of Nevada and auriferous quartz veins in eastern California; 2) those associated with Tertiary intrusives, typically base metal replacement deposits, usually in the eastern half of Nevada and western Utah; and 3) veins of silver and gold in Tertiary volcanics. In general, the deposits of type 1 occur in the area of volcanic and siliceous clastic geosynclinal deposits, and those of type 2 in the area of predominantly carbonate deposits except at Yerington, Nev., which is in the western part of the geosyncline. Deposits of type 3 occur throughout the province and the metals appear more related to a common source than to reactions with specific types of country rock. These rocks also contain small concentrations of radioactive minerals over most of the region. When the volcanics have been subdivided into lower Tertiary and upper Tertiary, a tectonically controlled pattern of deposits may be disclosed. Probably the different tectonic zones and sedimentary histories of these areas are responsible for these differences.

Kerr[46] noted similar distribution for the tungsten deposits, which are also related to Cretaceous and Tertiary intrusives and divisible into an eastern and a western group separated by a barren belt trending northward across central Nevada. Possibly this barren belt is more apparent than real.

C. W. Burnham[47] has mapped the distribution of several metals and trace elements in the western U. S. Almost all his maps show a pronounced north-northeast-trending zonation through central Nevada, corresponding to the trends of the various phases of the welt. The maps showing distribution of gold, silver, and tungsten deposits show greater density of points in western Nevada, with a secondary belt trending north-northeastward across Utah from the southern tip of Nevada. This latter belt corresponds to the eastern edge of the Basin and Range Province.

Replacement-type deposits of lead and zinc are almost exclusively in the eastern part of the province where the Paleozoic carbonates were deposited. Porphyry copper deposits occur in two areas: 1) western Utah—eastern Nevada and 2) extreme western Nevada—eastern California.

Deposits of quicksilver occur in western Nevada[48] and adjacent parts of California. Possibly they were formed by solutions associated with late Tertiary volcanism, but the source material was probably different from that which supplied late Tertiary volcanics in eastern Nevada and Utah.

Most of the ores are related to intrusions of granitic rock which may be either upper Cretaceous or middle Tertiary in age. Differentiation of the intru-

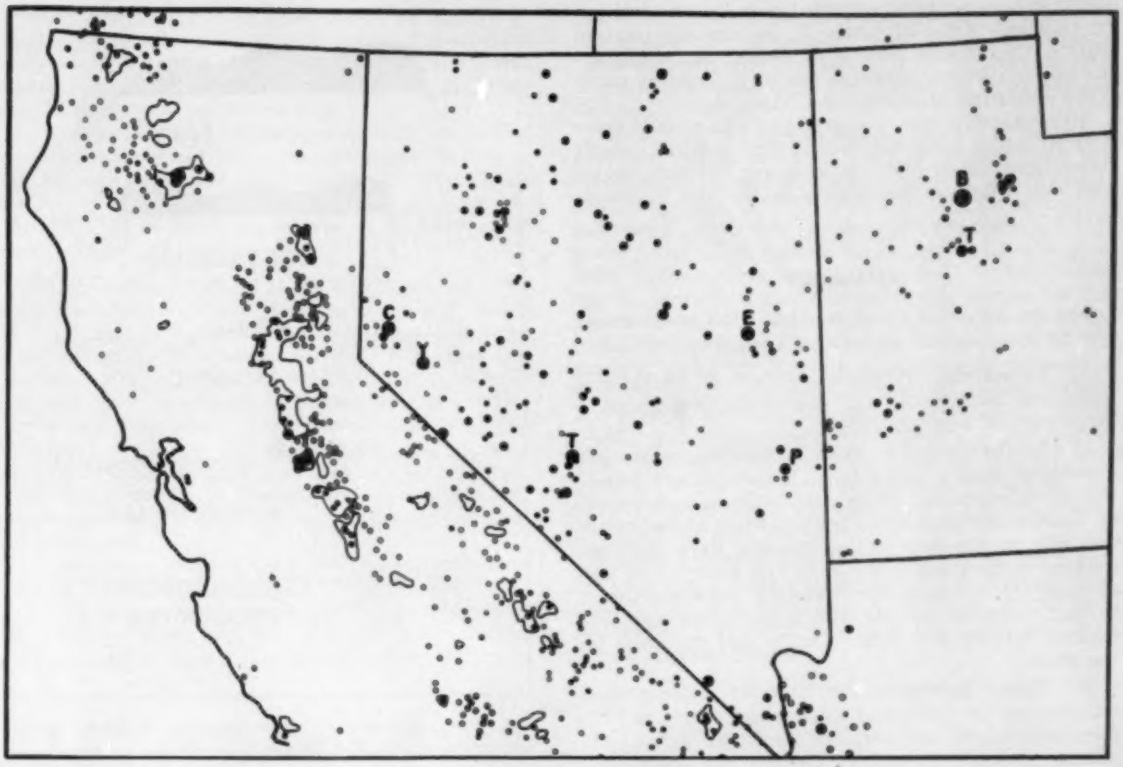

Fig. 17—Map by Jerome and Cook (1958) showing concentration of mining districts in the Basin and Range Province of Utah-Nevada-California. Size and darkness of circles indicate value of production and reserves. C, Comstock; Y, Yerington; T, Tonopah; P. Pioche; E, Ely; T, Tintic; B, Bingham.

sions of these ages will probably be of much aid in establishing exploration targets. The thrust faults of Mississippian and Cretaceous ages do not appear to exert a primary control on the intrusions of mineralization. These faults are mineralized, however, near the intrusions. The major movement on the range-bounding normal faults postdates the intrusions, but some of the initial fractures probably existed or were caused by uplift during the intrusion. Mineralization may occur along the earlier of these faults.

Some of these intrusions are along the axes of anticlinal folds. Discounting local uplift caused by the intrusions, it would be expected that the syntectonic Cretaceous intrusions would be more closely related to large anticlines than the post-Tectonic middle Tertiary intrusions.

RELATION OF PETROLEUM TO TECTONIC HISTORY IN WESTERN UTAH AND NEVADA

Smith[8] has summarized petroleum exploration in western Utah and Nevada. Two important phases were: 1) mapping and drilling of anticlinal structures probably formed during Cretaceous time exposed in the ranges and subsequently 2) gravity and seismograph mapping and drilling in the valleys.

Rocks of Ordovician, Silurian, Devonian, Mississippian, Pennsylvanian, Permian, and Tertiary ages in eastern Nevada and western Utah are similar to rocks of these ages which produce in Oklahoma, Texas, and the Appalachian region. These sediments are all intensely fractured and deformed to such an extent that primary accumulations probably have been dispersed into subsequent traps or dissipated.

Shows of oil are present in Mississipian and Tertiary rocks, but the others could also be the source of hydrocarbons and contain them.

Oil is being produced from only one field in the region: Eagle Springs, Railroad Valley, Nye County, Nev. The crude is very viscous, with a high pour point and is contained in a reservoir of fractured Tertiary volcanics and sediments and Permian limestone. This field was found by seismograph mapping and the accumulation probably is contained by overlying shales and updip closure against a major normal fault. There is no expression of closure at the surface; however, an alignment of warm springs east of the field may indicate the bounding fault. Lower Paleozoic rocks are exposed in the Grant Range two miles east of the oil field.

Tertiary rocks in the Egan Range, 30 miles to the east of Eagle Springs, contain similar hydro-carbons, and shows of oil have been obtained from them in a well drilling in the intervening valley (Standard Oil Co. of California No. 1, County Line Unit).

Chemical analyses of the oil produced at Eagle Springs are similar to analyses of the oil obtained from lower Tertiary rocks at the surface nearby and are different from the analyses of the oil in Mississippian rocks. If this observation indicates a lower Tertiary source for the oil, similar accumulations would be restricted to areas of lower Tertiary rocks beneath the valleys. If Mississippian rocks are also source beds for as yet unfound accumulations the prospective area is much larger.

There is a significant difference between the possibilities for accumulations of Mississippian and Tertiary oil and gas. This difference is the result of the

tectonic history. Mississippian source rocks and accumulations were subjected to intense deformation during Cretaceous time and normal faulting during upper Tertiary, whereas the lower Tertiary rocks were deposited after the major orogeny.

Significantly, the numerous granitic intrusions and volcanics have not caused any regional effects deleterious to oil from or in lower Tertiary rocks, and this may be assumed also for the Paleozoic rocks.

SUMMARY

The geologic history of western Utah and Nevada can be summarized as follows (Fig. 18):

1) **Proterozoic:** A thick sequence of clastic and carbonate sediments was deposited throughout a large part of western U. S.

2) **Lower Paleozoic:** The Cordilleran geosyncline developed with a hinge line (Wasatch line) trending north-northeast from the southwestern corner of Utah, separating a thicker sequence of carbonate deposits in the geosyncline from a very thin sequence on the shelf to the east. The geosyncline was divided by a hinge line trending north-northeast through central Nevada which separated the carbonates on the east from clastics and volcanics on the west.

3) **Upper Paleozoic:** An elongate tectonic welt was formed by uplift and intense compressional deformation along the trend of the hinge line in the middle of the geosyncline. Geosynclinal-type volcanic activity continued in the west and was absent in the east. The eastern part of the geosyncline and adjacent shelf broke into several prominent basins and uplifts. At the end of this time, the region ceased to be tectonically related to the belt peripheral to the nucleus of the North American continent.

4) **Mesozoic:** Uplift and eastward and westward expansion of the welt continued with corresponding migration of subsiding troughs on each flank. Geosynclinal volcanism continued west of the welt into Jurassic time. Intrusions of syntectonic granitic rocks were emplaced in eastern California and western Nevada during Cretaceous time. The welt included the region from the Wasatch line to the Sierra Nevada and was subjected to intense compressional deformation. During this time, the region became part of the Circum-Pacific tectonic belt.

5) **Lower Cenozoic:** Post-orogenic relaxation of compressional stresses, post-orogenic erosion, post-orogenic vulcanism, and post-orogenic granitic intrusion were active throughout the region. During this stage the region may have been comparable to the island arcs of the modern Circum-Pacific belt. The Tertiary basins to the east may have been equivalent to Umbgrove's idiogeosynclines (Ref. 50, Fig. 123), and the Sierra Nevada may have been equivalent to the nonvolcanic outer arcs.

6) **Upper Cenozoic:** Uplift of the western U. S. caused extension of the crust which resulted in tilting of large composite fault blocks. These form the present ranges and valleys of the province. Interior drainage systems developed, and the valleys have been filled. The volcanic-filled Snake River downwarp discordantly crosses the northern part of the province, and major strike-slip faults have caused dislocations in the southern part of the area. The asymmetric uplifts (monoclines) of the Colorado Plateau and Rocky Mts. may represent similar reaction to regional uplift but differ from those of the Basin and Range Province because of a shallower granitic basement.

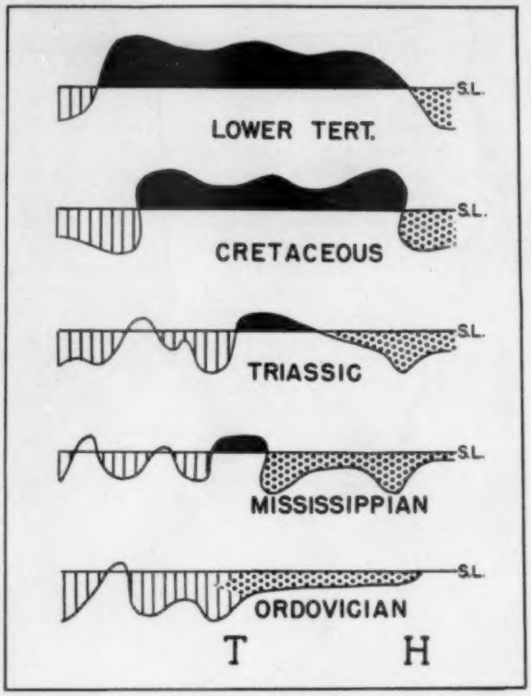

Fig. 18—Diagrammatic cross sections illustrate transformation of the Cordilleran geosyncline of the lower Paleozoic into the progressively enlarging welt (solid black) of later time. T is the transition zone between eastern and western parts of the geosyncline and H is the hinge between the geosyncline and the craton.

The structures (ranges and valleys) of the Basin and Range Province in Western Utah and Nevada are characterized by the following features:

1) The ranges are elongate and asymmetric, with steep *fronts* created by uplift along normal faults and more gentle tilted *dip slopes*. The ranges consist of several fault blocks tilted in the same direction, usually with the highest points of the blocks decreasing systematically in the direction of tilting. These conditions also exist beneath the valleys.

2) The valleys are the debris-filled depressions formed along the intersection of the lower tilted slopes of one mountain range and the steep *frontal* fault system of the adjacent mountain range. The valleys thus are asymmetric also, with their deepest part next to the highest part of the adjacent mountain range. The valleys have been filled to depths of several thousand feet by interior drainage systems, which have developed as the ranges grew.

3) The tilted blocks contain rocks which have been folded, faulted, and overthrust by various phases of at least two major orogenies. The normal faults cut across these structures and intrusives of Cretaceous and Tertiary age.

4) The normal faults may represent a second period of movement on faults originally formed as longitudinal faults or fractures on folds developed during previous orogenies.

5) The range fronts trend slightly east of north and are essentially straight in the gross, but that is,

in many cases, the cumulative effect of numerous small variations from the straight trend. The straight segments of the range front fault systems are interrupted serate fault patterns involving faults which trend obliquely across the ranges.

6) Major strike-slip faults trending northwest are probably present about 50 miles apart throughout the region. The Walker Lane is the best documented of these trends, which appear to have effected the location of the ranges or to have offset them.

The ranges and valleys of western Utah and Nevada are considered typical of the Basin and Range Province and have been compared with tilted fault block structures in Arizona, New Mexico, Texas, and northern Mexico. The physiographic similarity is real and may be related to a similarity of climate throughout this region since Cretaceous time. The structural similarity may be coincidental or, since the pre-Tertiary tectonic histories of the areas are quite different, it may indicate that the tilted fault blocks are Tertiary phenomena independent of previous tectonics.

Northward, tilted fault blocks are recognized in Oregon, Idaho, Montana, and Canada. Possibly a belt of these structures is parallel to the outside of the Circum-Pacific belt, but it is not recognized as such because of more intense pre-Tertiary deformation of less distinctive rock units. Exterior drainage has excavated the valleys, and the moist climate supports abundant vegetation. Both factors also add to the disimilarity with the arid areas of the Basin and Range Province.

The various tectonic phases and trends through the province appear to exert a primary control on the distribution pattern of various types of ore deposits. Further study of the intrusives and volcanics, especially geochemical age determinations, will greatly aid in delineating the trends, belts, and geologic history. Gravity studies appear to be a very useful method of determining configuration of the pre-Miocene rocks beneath the valley floors. Holes drilled in the valley will prove the accuracy of the gravity interpretations. It is reasonable to assume that additional ore deposits and oil accumulations are present beneath the valleys, and an ability to predict sub-valley geology will make it possible to find them. Much detail and regional geology will have to be done before the tectonic history of the province is completely and accurately known.

Sincere appreciation is expressed to the many geologists who have contributed to the geologic data used herein, especially to J. A. Peterson, R. H. Dott, Jr., and R. J. Roberts, who read the paper and suggested improvements.

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PRODUCTION OF SELF-FLUXING PELLETS IN THE LABORATORY AND PILOT PLANT

by K. E. MERKLIN and F. D. DeVANEY

Students of the modern blast furnace seem unanimously agreed that they are observing a major revolution in practice. Rather than changing construction and operation of the furnaces, most of the great advances now under way deal with the raw materials feed. Prepared burdens have gained increasing significance during recent years. Sizing, concentration, and agglomeration have all become bywords to greater production and reduced operating costs.

The remarkable results with test furnaces in which self-fluxing sinter makes up part or all of the ore charge foretell even greater improvements. Other investigators have reported many of these advances, and it is enough to predict here that more and more operators will turn to the use of self-fluxing sinter.

This change in the operator's requirements comes at a time when one major section of the iron ore regions, the Mesabi, is finding it difficult to maintain, let alone improve, the tonnage and grade of its shipping product. To meet the new demands with respect to quality and structure, the iron ore producers of this area turned first to screening, crushing, and concentrating intermediate ores. More recently, declining higher-grade reserves have led to multimillion-dollar investments in plants to treat the low-grade magnetic taconites.[1, 2]

To yield a suitable concentrate, the Minnesota magnetic taconites must be ground to about 80 pct through 325 mesh, too fine to be charged directly to the blast furnace or to make acceptable feed to the sinter strand. The pelletizing process was developed to meet the structure requirements laid down by the blast furnace operators.

Taconite producers are succeeding in their efforts just when the attention of the blast furnace man is being drawn to the great advantages of self-fluxing sinter.[3]

The taconite operators are ready with an alternative. Why not produce self-fluxing pellets? At the Hibbing laboratory of Pickands Mather & Co., where much of the early work was done that led to Erie Mining's 7.5-million ton taconite plant at Hoyt Lakes, Minn., preliminary investigations have been made.

Present Taconite Operations: Details of this work will be clarified by a brief review of agglomeration practice in commercial taconite plants. After the taconite has been ground to about 80 pct through 325 mesh to liberate the magnetite grains, the ore is concentrated on magnetic separators, thickened, and filtered to about 10 pct moisture. This structure and moisture fit in closely with the conditions required to produce good balls. It has been found with taconite concentrates that at least 60 pct of the feed to the balling drum must be −325 mesh to obtain good ball compaction within reasonable time. The filter cake moisture usually permits a slight water addition at the balling drum, and further balling control is obtained by adding about 12 lb of bentonite and 1½ lb of soda ash per dry short ton of concentrate. These additives, and occasionally small quantities of fine coal, are thoroughly mixed with the filter cake ahead of balling. The swelling property of bentonite improves the green and dry strength of the balls so they can be handled without breakage until they are fired. Soda ash is added for pH control to insure maximum performance of the bentonite, and coal is added for more heat in the firing process when required.

The balls, normally ⅜ to 1-in. diam, are brought to a temperature of 2350° to 2500°F in the indurating furnace. Heat for this process comes from three sources: 1) fuel burned in the combustion chamber, 2) oxidation of the magnetite concentrates to hematite, and 3) coal added to the balls.

Pellet strength is developed by grain growth and bridging and, if enough slag-forming constituents are present, by slag bonding. Conversion to hematite is usually close to 100 pct in the fired pellets.

Batch Test Procedures: Initial studies of self-fluxing pellets were made by producing balls on a batch basis under carefully controlled laboratory conditions. The 1-in. balls, uniform in size, were fired in an oxidizing atmosphere in a standard laboratory muffle furnace. The firing procedure consisted of

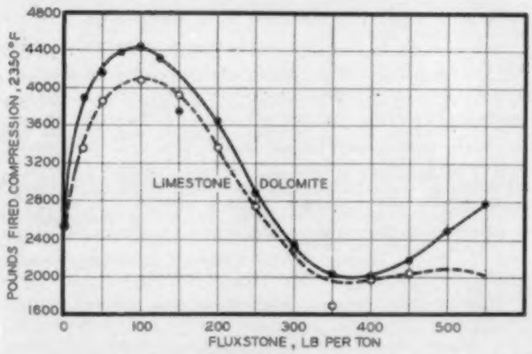

Fig. 1—The effect of the dolomite or limestone additions on the fired compressive strength of the pellets.

K. E. MERKLIN, Member AIME, is Chief Metallurgist, Hibbing Laboratory and F. D. DeVANEY, Member AIME, is Director of Research and Metallurgy, Pickands Mather & Co., Duluth, Minn. TP 59B88. Manuscript, April 23, 1959. San Francisco Meeting, February 1959. AIME Trans., Vol. 217, 1960.

drying 20 balls at 240°F for 24 hr in a constant-temperature ventilated oven, then transferring them to the muffle furnace at the same temperature. The furnace was then brought up to the desired firing heat over a 4-hr period, held at that temperature for 1 hr, and allowed to cool to 500°F or lower before the fired pellets were removed.

Quality Tests: If a ball is to withstand the rigors of mechanical handling and thermal shock before and after being introduced into an agglomerating furnace, it must meet certain minimum strength requirements. Three tests have been standardized for comparative evaluation of these properties. The drop test consists of individually dropping ten newly made balls onto a steel plate from a height of 18 in. The average number of drops the balls withstand before breaking is referred to as the *drop number*. Ten more green balls are subjected to a graduated compressive force on a Dietart core testing machine to obtain *green compressive strength*. Another ten balls are dried in a ventilated oven for 24 hr, then tested on the Dietart machine to determine their *dry compressive strength*. To meet commercial requirements, the balls must pass all three tests.

Ban and Erck[4] have described three methods that are now accepted standards for evaluating small quantities of fired pellets—the compression test, the tumble test, and the drop test were all used in various phases of this work. The tumble test was varied for evaluation of pilot plant products where larger quantities of pellets were available, to conform to that currently in use at the Erie taconite plant. This is based on the ASTM standard coke test, with modifications to meet the specific requirements for evaluating pellets.

The sample for this test consists of pellet material remaining on a 3-mesh (0.263-in.) screen, with any fused cluster eliminated.

1) A 25-lb (11,320-g) dry sample of + 3 mesh is used.

2) This sample is tumbled in an ASTM coke tumbler for 200 rev at 24 rpm.

3) The tumbled pellets are hand-screened on a 3-mesh screen.

4) Material passing through 3 mesh is screened on a Rotap for exactly 3 min with a Tyler 10-mesh screen.

5) The percent + 10 mesh is reported as the tumble index.

An average tumble index of 85 is considered good for production pellets. The specific gravity of the pellets was determined by the displacement-in-mercury method. The apparent specific gravity of the pellet, including voids, is recorded.

Quantity and Structure of Fluxstone: Parallel tests with limestone and dolomite revealed a slight advantage in using dolomite in self-fluxing pellets. Fig. 1 shows comparable fired compressive strengths of pellets made with varying quantities of both.

Many earlier investigations of the use of additives in pelletizing had indicated that neither dolomite nor limestone would effectively replace bentonite. At no time, however, had these materials been used in the large ratios that would be required to produce self-fluxing, so a series of tests were conducted in which −100 mesh dolomite was used in varying quantities, without other additives, with the results shown in Table I. It will be noted that no ratio of dolomite tested gave anywhere near the minimum green and dry compressive strengths desired. This was as expected, and in all subsequent work the standard amounts of bentonite and soda ash were added.

Table I. Pellet Quality vs Dolomite Addition. No Other Additives

Test	Dolomite Added, Lb Per Ton	Drops Tests	Compression Tests: Green	240°F, Dry	2350°F, Fired
1	25	3.0	5.71	3.20	1724
2	50	3.8	5.87	4.68	1925
3	75	4.0	5.81	5.56	1600
4	100	4.2	5.90	4.99	1456
5	125	4.0	5.97	4.14	1407
6	150	4.1	5.93	4.24	1336
7	200	3.7	6.06	4.02	1279
8	250	3.4	5.78	4.68	1229
9	300	3.6	5.90	4.05	1157
10	350	2.9	4.93	4.55	1143
11	400	3.3	5.28	4.74	1136
12	450	3.1	5.18	4.49	1093
13	500	2.9	5.34	4.55	1093
14	550	2.9	5.28	4.65	1057
Minimum		5.0	12.00	30.00	1500

Table II. Pellet Quality vs Dolomite Addition. Other Additives Standard

Test	Additive, Lb Per Ton: Bentonite	Soda Ash	Dolomite	Drop Tests	Compression: Green	240°F, Dry	2350°F, Fired
Minimum	—	—	—	5.00	12.0	30.0	1500
Standard	12	1.5	—	6.30	13.6	58.7	2500
1	12	1.5	25	7.00	13.50	46.91	3888
2	12	1.5	50	8.70	13.41	47.37	4153
3	12	1.5	75	9.20	14.35	47.51	4389
4	12	1.5	100	8.90	13.63	47.67	4458
5	12	1.5	125	9.20	13.66	46.88	4319
6	12	1.5	150	9.70	12.91	46.51	3764
7	12	1.5	175	9.70	13.13	45.47	3667
8	12	1.5	200	9.20	13.19	45.84	3667
9	12	1.5	225	9.20	12.81	45.01	3306
10	12	1.5	250	9.20	12.75	44.92	2903
11	12	1.5	275	8.80	12.62	43.73	2667
12	12	1.5	300	8.60	12.69	43.89	2317
13	12	1.5	325	8.40	12.50	43.90	2113
14	12	1.5	350	8.40	12.53	43.96	2088
15	12	1.5	375	7.40	12.81	43.89	2017
16	12	1.5	400	7.40	12.84	43.99	2000
17	12	1.5	425	7.40	12.28	43.83	2044
18	12	1.5	450	6.90	12.21	43.48	2194
19	12	1.5	475	6.80	11.99	43.49	2267
20	12	1.5	500	6.60	11.89	42.77	2494
21	12	1.5	525	6.00	11.88	41.03	2625
22	12	1.5	550	5.60	11.84	40.54	2758

With the standard additives included the green, dried, and fired balls showed acceptable strengths with any quantity of dolomite within the range tested. However, as Table II shows, maximum dry and fired strengths occurred with an addition of 75 to 100 lb.

The higher compressive strength in Table II, as compared with that in Table I, is attributed to the bentonite and soda ash additions. These additives contribute to the fired strength partially by their chemical characteristics, but mostly because of improved compaction on balling.

All pellets with fluxstone additions, within the range tested, had an average apparent specific

Table III. Influence of Dolomite

Test No.	Dolomite Structure	Additives, Lb Per S.T.: Bentonite	Soda Ash	Dolomite	Drop Test	Compression: Green	240°F, Dry	2350°F, Fired
1	−14M	12	1.5	350	8.5	12.28	40.04	1495
2	−28M	12	1.5	350	8.5	12.35	41.20	1643
3	−65M	12	1.5	350	8.6	12.52	43.14	1894
4	−100M	12	1.5	350	8.7	12.53	43.96	2088

gravity of 3.85 to 4.0, 0.1 to 0.25 points higher than that normally obtained with standard laboratory pellets. Extensive shrinkage was obvious on visual examination.

It was found, as reported in Table III, that the finer the dolomite was ground, within the limits tested, the higher the quality of the balls produced, as indicated by the important dry and fired strength classifications. The work that followed was, therefore, based on these premises:

1) That —100 mesh dolomite be used. An even finer size might show some advantages but was not considered since it would be difficult to obtain or produce should a commercial application result.

2) The fluxstone should be added in such amount that the bases would about equal the acids in the final product. In this case it will be noted that the addition required was at the lowest point on the fired compressive strength curve (Fig.1).

The structure and chemical analyses of the concentrates and dolomite used in the subsequent batch and pilot plant tests are shown in Table IV and V.

Table IV. Screen Analysis of Raw Materials

Product Size, Mesh	Concentrate, Wt Pct	Dolomite, Wt Pct
+28	0.08	—
+35	0.08	0.08
+48	0.08	0.16
+65	0.31	1.17
+80	0.08	0.86
+100	0.15	1.25
+150	0.38	3.21
+200	3.30	7.99
+325	11.67	19.73
−325	83.87	65.55
Total	100.00	100.00

Table V. Chemical Analysis of Raw Materials

	Assay, Pct								
Product	Fe	P	SiO	Mn	Al	CaO	MgO	S	Ig. Loss
Concentrate	64.91	0.006	7.98	0.26	0.18	0.31	0.19	—	—
Dolomite	0.99	0.011	1.30	0.03	0.60	29.46	20.35	0.009	46.90

Mineralogy and Structure of Fired Pellets: With 350 lb of dolomite per dry short ton of concentrates, plus the regular additives, balls were made and fired at chamber temperatures of 1800° to 2350°F in the muffle furnace. The balls were then sectioned and polished following the procedure described by Cooke and Ban.[8] Fig. 2 shows that at 1800°F the calcined dolomite particles still retain their identity though in a loosely consolidated state. The magnetite has been converted to hematite, and the quartz grains are readily indentifiable. What little gain in strength the pellets have comes from some slight indications of bridging between hematite grains. Macroscopically, these pellets are reddish gray, speckled with dots of dolomite residue.

At 2000°F the pellets are reddish brown with many white dots of dolomite residue still in evidence, although these are not quite so common as at the lower temperature. Physical strength is still poor. As shown in Fig. 3, the calcined dolomite is the dominating feature. The quartz grains still retain their identity with some evidence of slagging in areas adjacent to dolomite particles. It is interesting to note that MgO from the dolomite has started to react with the adjacent hematite grains to produce magnesioferrite. Both bridging and slag bonding have contributed to the strength of these pellets.

Pellets fired at 2150°F are reddish blue, with a very few white specks of dolomite residue. They show considerably improved physical properties. The typical section in Fig. 4 shows that the slagging constituents have reached a semifluid to fluid state and that slag bonding is common. Small particles of hematite are closely grouped in the slag and tend to seek a spherical shape due to surface tension.

At 2350°F the pellets are steel blue, and no evidence of the dolomite is visible to the naked eye (Fig. 5). The pellets possess excellent mechanical

Fig. 2—Section of pellet containing 350 lb of dolomite per ton, fired at 1800°F. The white is hematite, the light gray is residual dolomite, and the dark gray crystals are quartz. Voids are filled with plastic. X350.

Fig. 3—Section of pellet similar to that shown in Fig. 1, fired at 2000°F. Note intrusion of magnesioferrite into hematite grains adjacent to the dolomite. X350.

Fig. 4—Section of pellet similar to the one shown in Fig. 2, fired at 2150°F. A slag bond has formed between some of the groups of hematite grains. X350.

Fig. 5—Section of pellet similar to the one shown in Fig. 2, fired at 2350°F. Slag forms a continuous network surrounding the growing hematite grains. X350.

Fig. 6—A pellet that is fired at 2350°F without the addition of dolomite shows grain growth, bridging, and complete conversion of magnetite to hematite. X350.

Fig. 7—This section shows a pellet fired at 2350°F containing 550 lb of dolomite. Gray grains are magnesioferrite. The mechanism of grain growth is clearly illustrated. Note the curved faces of some hematite grains which have been excavated by the rotation of the adjacent growing crystals, as indicated by A and B. X350.

Fig. 8—Pellet produced from specular hematite plus 350 lb dolomite. Gray areas are magnesioferrite. X350.

Fig. 9—This pilot plant pellet, containing 350 lb of dolomite, was fired at a combustion chamber temperature of 2000°F without coal. X350.

Fig. 10—This pilot plant pellet, similar to the one illustrated in Fig. 8, was fired at a combustion chamber temperature of 2000°F with 20 lb of coal. X350.

Fig. 11—This pilot plant pellet, which is similar to the one in Fig. 9, was fired at a combustion chamber temperature of 2100°F with 20 lb of coal. X350.

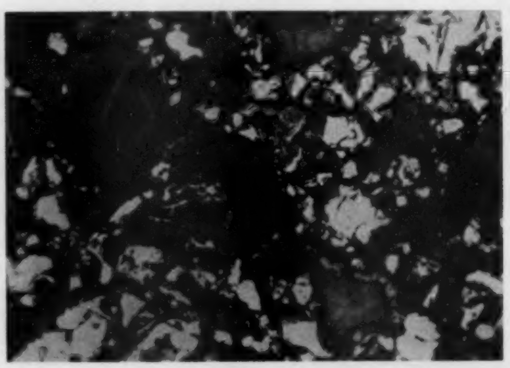

Fig. 2

Figure 3

Figure 4

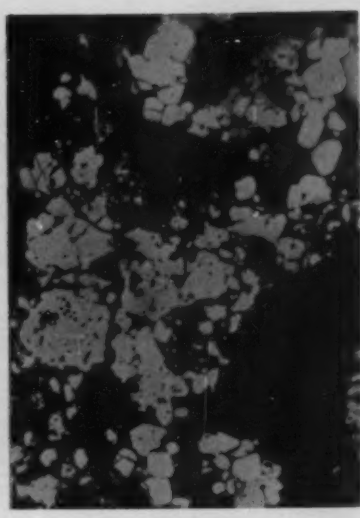

Figure 5

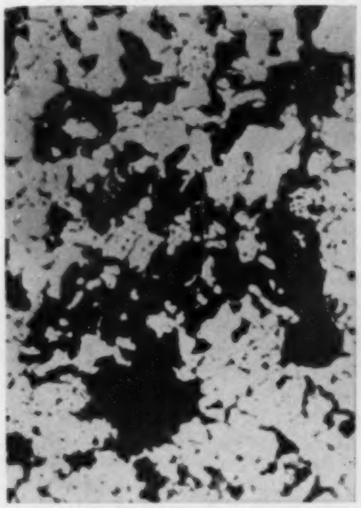

Figure 6

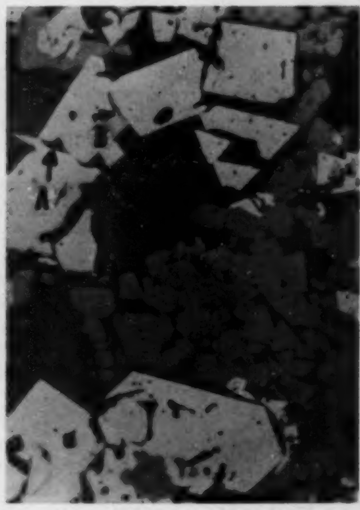

Figure 7

Figure 8

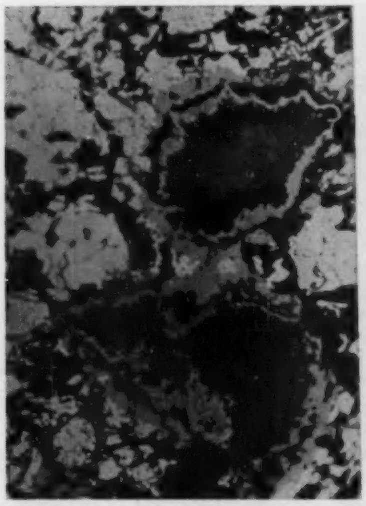

Figure 9

Figure 10

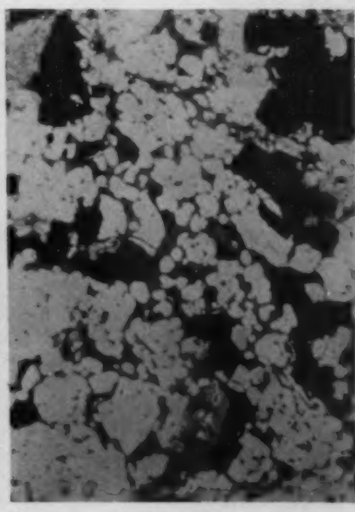

Figure 11

properties. They have shrunk considerably more than those fired at lower temperatures or pellets without dolomite fired at the same temperature. Under the microscope they show a continuous silicious slag network similar to that described by Cooke and Ban for pellets fired in a neutral atmosphere at 1200°C (2192°F).[5] Voids are larger but fewer in number. Freedom of movement of the hematite particles through the large volume of slag has led to formation of clusters of large grains at the expense of the smaller ones. Slag bonding has replaced bridging as the major source of pellet strength.

Formation of Magnesioferrite: Pellets produced from magnetic taconite concentrates and fired in the manner described are usually almost completely oxidized to hematite. Examination of the series of pellets to which 350 lb of dolomite had been added showed that as the temperature of firing was raised, the percent magnetics increased. Results of Davis magnetic tube tests on crushed fired pellets from this series are shown in graphic form in Fig. 12. The percent magnetics also varies with the quantity of dolomite added, as shown in Fig. 13.

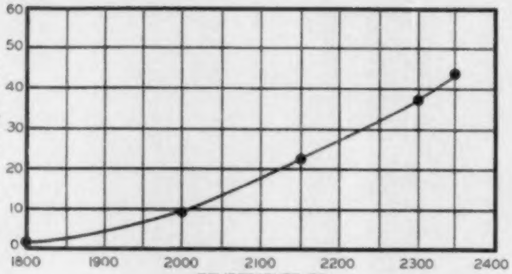

Fig. 12—Percent magnetics vs firing temperatures.

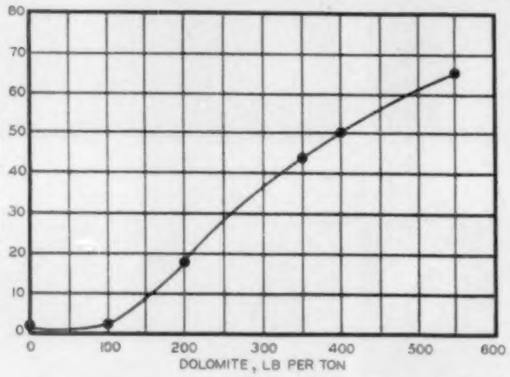

Fig. 13—Percent magnetics vs quantity of dolomite added.

The varying magnetic fraction can be explained as follows:

1) In the presence of available MgO, hematite at elevated temperatures easily forms a magnesioferrite spinel in accordance with the following equation: $MgO + Fe_2O_3 \rightarrow MgO \cdot Fe_2O_3$. Magnesioferrite is strongly magnetic and in polished section cannot be distinguished from magnetite, since both are isometric and isotropic.

2) In pellets made from magnetite concentrates, where only part of the magnetite has oxidized to hematite, a spinel-type mineral will form in the presence of magnesium oxide, the composition of which is $(Fe^{++},Mg^{++})O.Fe_2O_3$. This mineral is also magnetic, isometric, and isotropic.

Table VI shows that the amount of ferrous iron, as well as the total magnetics, varies with both the firing temperature and the amount of dolomite addition. It seems probable that this is related to the formation of $(Fe^{++},Mg^{++})O.Fe_2O_3$ together with possibly a small percentage of residual magnetite.

Table VI. Magnetic Tube Tests on Fired Pellets

	Description		Pellet		Tube Concentrate		
Fig.	Dolomite Added, Lb Per S.T.	Firing Temp, °F	Total Iron	Ferrous Iron	Wt, Pct	Total Iron	Ferrous Iron
1	350	1800	56.34	0.17	1.65	56.71	0.44
2	350	2000	56.63	0.21	9.35	57.22	0.50
3	350	2150	56.84	0.33	22.40	56.67	0.66
4	350	2350	56.67	3.51	43.65	56.38	7.36
5	None	2350	61.58	0.39	0.46	65.46	15.63
None	100	2350	60.91	0.70	2.00	60.12	1.57
4	350	2350	56.67	3.51	43.65	56.38	7.36
6	550	2350	55.51	6.85	65.64	55.13	10.07
8*	350	2350	57.88	0.16	63.73	56.17	0.16

* Pellets made from specular hematite.

This phenomenon was examined further by the production of a batch of pellets from specular hematite concentrates following the same procedure used in producing balls from the magnetite concentrates. Tube tests recovered 63.73 pct of the weight of these pellets as magnetic. Since there was little if any magnetite available, $MgO.Fe_2O_3$ was formed rather than the more complex spinel. The small percentage of ferrous iron in these pellets would tend to substantiate this conclusion. Fig 8 shows a typical section of one of these pellets and the large proportion of magnesioferrite present.

These findings are reported only as a matter of interest. There is no basis for believing that the presence of magnesioferrite will interfere with the acceptability of self-fluxing pellets to the blast furnaces.

Pilot Plant Tests: Batch tests find their ultimate value when they supply information that is useful in operating a pilot or production plant. Pilot plant tests were the next logical step in this investigation.

Several tons of dolomite were crushed and wet-ground to the structure shown in Table IV. All pilot plant tests were run using 350 lb of dolomite, plus the standard 12 lb of bentonite and 1.5 lb of soda ash per dry short ton of commercially produced taconite concentrates. During the first three tests, fine anthracite coal was also added at 20 lb per ton.

A balling drum 3 ft diam by 8 ft long and a shaft furnace 30 in. diam by 18 ft high were used for pilot plant agglomerating at a feed rate of about 0.6 LTPH. As DeVaney has detailed the design and operation of the modern shaft pelletizing furnace,[6] comments here will be confined to results from the four pilot plant tests.

These tests were directed toward determining the optimum feed rate and temperature conditions at which pellets of satisfactory quality would be produced. Past experience with magnetic taconite concentrates had shown that at a feed rate of 0.6 LTPH a combustion chamber temperature of 2300°F would produce an excellent fired pellet without the addition of coal. Taking into consideration the added heat requirements for calcining the dolomite and the loss per ton in heat of oxidation of the magnetite that was being replaced by dolomite, it was

Table VII. Pilot Plant Operating Data

Test No.	Combustion Chamber Temperature, °F	Coal Addition, Lb Per Ton	Total BTU Consumption Per Ton of Product
1	2300	20	1,219,800
2	2100	20	990,200
3	2000	20	921,600
4	2000	None	824,600

calculated that about 20 lb of anthracite fines should be added to each ton of concentrate. The heat input was varied from this point downward as shown in Table VII. It should perhaps be re-emphasized here that the temperature of the combustion chamber is not a measure of the temperature in the indurating zone of the shaft. The temperature of the indurating zone will be considerably higher owing to heat from the coal and oxidation of the magnetite.

The first test was abandoned when it became obvious from furnace operation and the clusters of fused pellets being discharged that the heat input was too high. The combustion chamber temperature was dropped to 2100°F, and test No. 2 was conducted without difficulty. For tests 3 and 4 the combustion chamber temperature was 2000°F. Coal was added for test 3 but not for test 4.

Table VIII. Physical Properties of Pilot Plant Pellets

Test No.	Description	Tumble Index	Sp Gr
2	2100°F with coal	95	3.94
3	2000°F with coal	93	3.74
4	2000°F without coal	91	3.63
	Standard	85	3.67

Table VIII shows the results of tumble and specific gravity tests on samples from each of the last three runs. The higher specific gravity of the pellets produced in test 2 must be a measure of greater slag fluidity permitting more rapid grain growth and pellet size shrinkage. The higher tumble index bears a similar significance. This relationship is even more obviously established when the pellet sections are examined under the microscope (Figs. 9-11).

Reducibility tests were run on the pellets produced in tests 2-4, using the loss-in-weight method developed by the USBM in Minneapolis.[7] Results are shown in Table IX, together with those of a parallel

Table IX. Reduction Time for Self-Fluxing Pellets

Time, Min	Test No. 2 2100°F With Coal	Test No. 3 2000°F With Coal	Test No. 4 2000°F Without Coal	2300°F Standard Pellets
5	24.95	17.57	12.67	17.44
10	39.01	30.39	29.16	28.31
15	51.30	40.41	42.36	38.19
20	59.91	47.44	49.48	47.89
25	65.36	51.48	57.29	55.96
30	72.92	58.51	63.88	62.38
35	78.54	63.60	70.31	70.94
40	84.69	—	76.38	—
45	—	72.04	80.38	80.98
50	91.54	—	—	—
55	—	76.96	87.67	90.86
60	94.53	—	—	—
65	—	82.23	92.01	95.79
70	94.70	—	—	—
75	—	85.74	94.96	97.44
80	94.70	—	—	—
85	—	87.49	95.31	97.44
90	94.70	—	—	—
95	—	89.61	95.48	97.61
100	95.23	—	—	—
110	—	90.49	—	97.77
120	96.46	—	—	—
130	—	91.01	—	—

test on regular pellets from a commercial plant. Self-fluxing pellets appear somewhat slower to reduce, which can no doubt be attributed to the sealing off of some areas by the slag bond and possibly to slower reduction of the magnesioferrite. It seems doubtful, however, that reducibility tests give the full picture of the relative value of these products in the blast furnace. The pre-calcining of the fluxstone and its intimate distribution throughout the charge would appear to be more important factors.

The chemical analysis of the pilot plant product is shown in Table X.

Table X. Chemical Analysis of Fired Pellets

Test No.	Description	Assay, Pct							
		Iron	Ferrous Iron	Ferric Iron	P	SiO_2	Mn	CaO	MgO
2	2100°F, with coal	58.16	0.65	57.51	0.006	7.65	0.23	4.30	2.52
3	2000°F, with coal	58.16	0.64	57.52	0.006	7.68	0.23	4.37	2.51
4	2000°F, without coal	58.14	0.66	57.48	0.006	7.66	0.23	4.28	2.55

SUMMARY

Batch and pilot plant tests have provided enough background information to permit operators of commercial plants to proceed with confidence to production of self-fluxing pellets. Some precautions will have to be observed to avoid high pelletizing temperatures, since the large volumes of slagging materials present could quickly form chunks or wall build-up in the unsuspecting operators' furnace. The type of internal bond is different from that obtained in the present product but should provide satisfactory resistance to mechanical destruction. It is probable that an acceptable pellet strength will be obtained at lower furnace-operating temperature than that currently being used in commercial plants.

Within recent months producers have sent out several shipments of self-fluxing or flux-added pellets. Blast furnace results have not yet become available. It seems reasonable to predict, however, that self-fluxing pellets will show the same degree of improvement over regular pellets that self-fluxing sinter has shown over regular sinter.

The authors are indebted to S.R.B. Cooke, who materially assisted with some of the technical problems; M. H. Childs, who prepared the specimens and photomicrographs; W. R. Van Slyke, who read the manuscript; and those at the U. S. Bureau of Mines in Minneapolis who conducted the reducibility tests. They also express appreciation to Pickands Mather & Co. for permission to publish these findings.

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Discussion of this article sent (2 copies) to AIME before April 30, 1960, will be published in MINING ENGINEERING.

GEOLOGIC SETTING OF THE NICKEL OCCURRENCES ON JUMBO MOUNTAIN, WASHINGTON

by JOSEPH W. MILLS

In 1956 the discovery of nickel on Jumbo Mountain, Snohomish County, Washington, focused attention on this part of the Cascade Range, far more renowned for its timber than for its mineral resources. Hand specimens assaying as high as 13 pct Ni encouraged Discovery Mines Inc. of Mount Vernon, Wash., to stake 12 claims in Township 31 North, Range 9 East of the Willamette Meridian. The property was leased to Climax Molybdenum Co. in January 1957. Trenching, sampling, and geologic studies were carried out during the late summer of 1957 when most of the snow had disappeared. Although the deposits are only about four miles south of the logging town of Darrington and about two miles, as the crow flies, southeast of the end of a good gravel road from that town, all camp supplies and equipment were air-dropped, owing to the extremely rugged nature of the terrain.

GEOLOGY

The rocks of Jumbo Mountain comprise a series of folded Tertiary sediments forming a belt one half to three quarters of a mile wide, trending northwest about parallel to the strike of the beds. This belt is sandwiched between two extensive intrusives—gabbro on the northeast and quartz diorite on the southwest—and has been intruded by dikes of fresh and serpentinized dunite. Shear zones follow many of the dunite-sedimentary rock contacts, and in these the nickel mineralization is concentrated. A few transverse faults offset the sediments and ultrabasics.

J. W. MILLS is Associate Professor, Department of Geology, Washington State University, Pullman, Wash. TP 591227. Manuscript, April 6, 1959. Pacific Northwest Regional Conference, Spokane, Wash., April 1958. AIME Trans., Vol. 217, 1960.

Sedimentary Rocks: Two kinds of quartzite make up the greater part of the sedimentary section. One is dark purplish gray, very fine-grained, and thin-bedded; the other is light gray to white, medium-grained, and well-bedded. Locally the light-colored quartzites contain grit and conglomerate horizons, rich in pebbles of white chert and very fine-grained quartzite. Intercalations of dark argillites near the summit of the mountain give many of the cliffs a striking banded appearance. Dark gray to black, aphanitic, thin-bedded argillites occur throughout the entire sedimentary belt. Beds vary from a few inches to a few tens of feet thick and some, near the summit, contain numerous fossile (willow?) leaves. Only the thicker beds were mapped.

The sediments are quite fresh on the northeastern side of the belt and become more metamorphosed (hornfelsed) toward the southwestern side. Brown biotite is present in the metasediments in increasing amounts as the quartz diorite is approached. Near the intrusion, porphyroblasts of plagioclase, up to 1 in. across, testify to the soaking of sedimentary rocks by solutions emanating from the quartz diorite.

Most of the sediments mapped lie along the southwestern limb of an anticline, the axis of which follows the crest of the mountain and plunges at a low angle to the northwest.

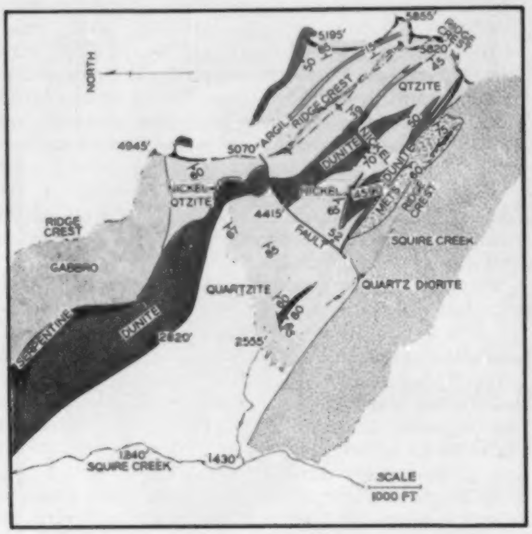

Fig. 1.—Geologic plan of Jumbo Mountain.

Vance[1] correlates the sediments of Jumbo Mountain with the Swauk formation and points out:

> The Swauk formation . . . is part of a long, narrow north-northwest-trending belt of continental sediments extending over 50 miles with several gaps from the type area south of Mt. Stuart to the present area, thence almost 50 miles farther with a few more breaks to the Bellingham area where the same unit has been called the Chuckanut formation. . . . The Swauk appears to owe its preservation in this narrow belt to faulting and in part to sharp downfolding.

Ultrabasic and Basic Igneous Rocks: Intrusive into the sediments are numerous dikes of fine-grained, black to grayish green, coarse-grained dunite, composed almost entirely of iron-poor olivine or its alteration products, talc, tremolite, and serpentine. Commonly the rock weathers a characteristic orange-brown color. Dikes vary from a few feet wide and a few hundred feet long to great tabular bodies several hundred feet wide and miles long.

Within the map area there are three large persistent dikes of dunite, all striking about parallel to the sedimentary rocks. The eastern one was not mapped in its entirety; it lies to the east of the fold axis and dips southwesterly directly across the sedimentary beds. This dunite dike is fine-grained and dark green-gray to black. It contains abundant talc and serpentine, together with less than 1 pct of exceedingly small pyrrhotite grains. Although the dike is quite schistose, especially along its margins, no promising nickel mineralization has so far been found in it on this side of the mountain. The dike transects the folded early Tertiary sediments and is itself truncated to the northwest by the gabbro intrusive.

The other two major dikes, lying southwest of the anticlinal axis, strike and dip about parallel to the sediments, though locally they cut across the bedding at low angles. They differ in size but are quite similar in other respects—characteristically they are somewhat darker and finer-grained along the margins than at their centers, invariably they contain a sprinkling of very small pyrrhotite grains, and frequently they are crisscrossed by thin films of crystalline talc. Locally, they are schistose for a few feet from their contacts, and it is these schistose zones which are mineralized with pyrrhotite and pentlandite. The dikes die out along the strike and up and down the dip by branching and intertonguing with the sediments.

The southwest dike, the smaller of the two, pinches out to the southeast just a few feet from the summit, cropping out again on the southeast (unmapped) side of the mountain at about the same elevation. The implication is that this and probably other dunite bodies are tabular-lenticular branching bodies which, like the folds, have low angles of plunge.

The central portion of the dunite dike that lies south of the gabbro intrusive is exceedingly coarse-grained. Differential weathering has removed the finer-grained matrix and left striking euhedral crystals of olivine, up to an inch long, projecting from the weathered rock surface.

At least locally and to a minor degree, all the dikes show alteration of the dunite to serpentine. This is more pronounced along the borders where schistosity has been developed. The area between the gabbro and the largest dunite dike is noteworthy for a volume of serpentine at least a mile long and more than 200 ft wide, composed entirely of glossy, moderately schistose serpentine. It is not known whether this rock is the product of dynamic metamorphism of the dunite or the product of contact metasomatism by solutions that originated in the gabbro mass.

Gabbro: The belt of sedimentary rocks on Jumbo Mountain is bordered on its northeast side by one or more basic intrusions. The northwest end of the mountain is made up of a green, medium to coarse-grained, massive gabbro. The truncation of the dunite dike and of the sediments at the south end of the gabbro body is interpreted as indicating a post-dunite and hence a Tertiary age for the gabbro. It has been intruded along the anticlinal fold axis.

A thin section shows this rock to be composed of about equal amounts of rather basic (An 65) saussuritized plagioclase and fibrous uralitic hornblende, with its alteration products, epidote, silica, and chlorite. Minor amounts of very fine-grained secondary silica and talc were visible under the microscope, as well as numerous grains of sphene and/or ilmenite.

Acid Igneous Intrusives: Bordering the sedimentary belt on the southwest, and intruding into

Fig. 2—Crest of Jumbo Mountain, looking southeast.

it, is a light-colored, medium to coarse-grained quartz diorite composed of plagioclase, hornblende, brown biotite, and minor quartz. This is the northern limit of a great stock, called by Vance[1] "the Squire Creek Quartz Diorite," which occupies an area of some 30 sq miles. According to Vance, "the stock is a roughly elliptical body, the larger axis of which trends about N 30 W, approximately parallel to the structural trend of the adjacent country rocks." He considers the stock "to be of igneous origin . . . indicated by the uniformity of the quartz diorite and by its universally sharp contacts. . . . Textures are dominantly magmatic." Within the map area the stock probably dips at a very steep angle to the south.

Light gray to white fine-grained aplite dikes are found cutting the quartz diorite and the metasediments. Seldom more than a foot wide, these dikes cannot be shown on a map the scale of this study. The aplite is a differentiation product of the quartz diorite magma.

Faults: The faults are either longitudinal or transverse. Longitudinal faults occur along and just within the borders of the dunite dikes; the schistosity, developed as a result of fault movement, is further discussed below. Transverse faults are characterized by narrow, clean-cut surfaces of dislocation which cut across the sedimentary belt, strike from east to a few degrees north of east, and dip steeply southeast. Two transverse faults have been recognized, each offsetting dunite dikes in the central part of the map area. The largest dunite dike has been offset at least a couple of hundred feet on the larger fault, the north side apparently having moved east. The actual net slip on the transverse faults is unknown. They contain no sulfide mineralization.

NICKEL DEPOSITS

In all three principal dunite dikes, minute disseminated grains of pyrrhotite are to be seen in the fresh rock in amounts less than 1 pct. Traces of nickel have been reported from many such specimens. Nickeliferous pyrrhotite is the principal nickel-bearing mineral, although olivine contains very minor amounts of nickel in solid solution, substituting for magnesium and iron. Such occurences are of no economic significance.

Nickel analyses of possible economic significance (up to 3 pct Ni) have been returned from samples taken near the margins of the two large western dunite dikes. These samples were from schistose zones along and within the dike walls. The mineralized shear zones, up to 30 ft wide, strike N 30 W and dip from 65° to 90° west. They consist of layers of hard, fresh, green-gray dunite, mineralized with finely disseminated pyrrhotite. These layers alternate with layers of soft, black, oxidized schistose dunite up to 1 ft wide, well mineralized with pyrrhotite and tabular-fractured pentlandite in crystals up to ¼-in. diam.

Sulfides identified in polished sections were chiefly pyrrhotite and pentlandite, with much smaller amounts of chalcopyrite. There are two varieties of pyrrhotite. One develops a fine polish and conforms to published descriptions. The other is slightly darker and browner, does not polish as well, and displays flamelike growth or intergrowth structure when etched with nitric acid fumes. Pyrrhotite and pentlandite crystallized contemporaneously in the form of veins in the olivine and as fillings of the interstices of euhedral olivine crystals. Chalcopyrite replaces the other sulfides.

The most striking feature of the deposits is their occurrence in intimately fractured and schistose zones in the dunite where faulting has been localized along the contacts of the sediments and the dunite dikes. Though far too little detailed work has been done to be certain, there appears to be a higher concentration of sulfides in the shear zones along the margins of dike apophyses, sediment rëentrants, and strike and dip irregularities.

Much more study would be required in order to submit a plausible theory of formation of the nickel deposits, supported by laboratory and field evidence. Results of the present study, especially localization of the metals by fracturing, certainly indicate that the nickel concentrations were brought about by precipitation of nickel sulfides from fluids that used the fractures as a means of ingress. Studies of nickel sulfide deposits throughout the world have demonstrated that such sulfides were deposited at considerable depths and at temperatures of several hundred degrees. This would rule out the possibility of groundwater as the transporting medium. The two possible sources of hot nickel-bearing fluids are quartz diorite and gabbro. The first possibility is that large volumes of fluids, expelled from the quartz diorite magma during its crystallization, obtained a supply of nickel by altering the nickeliferous olivine of the dunites. The likelihood of this process is lessened by the recognition that, although the dunites show some alteration to serpentine, talc, and tremolite, they are for the most part remarkably fresh outside the schistose zones. The worldwide association of nickel with basic rocks, together with the presence of pyrrhotite in thin films on joint planes of the gabbro on Jumbro Mountain, favors the gabbro source.

The writer extends thanks to C. Phillips Purdy, Jr., project chief of American Metal Climax Inc., for giving him the opportunity to study these deposits. He is also indebted to the officers of American Metal Climax Inc. and Discovery Mines Inc. for permission to publish this article.

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[1] J. A. Vance: The Geology of the Sauk River Area in the Northern Cascades of Washington. Doctoral dissertation, University of Washington, 1957.

Discussion of this article sent (2 copies) to AIME before April 30, 1960, will be published in MINING ENGINEERING.

Correction. In the November 1959 issue: Pebble Milling Practice at the South African Gold Mines of Union Corp. Ltd. O. A. E. Jackson. On p. 1134, col. 2, par. 2, sentence beginning line 6 should read: "In 1948 two 12x16-ft pebble mills. . . ." P. 1136, Table III, col. 7 first figure should read "0.395" instead of "0.246." P. 1141, Table IX, right-hand column, "15° cone cyclone" should read "20° cone cyclone" in each case, and in Table X, right-hand column, the heading should read: "12x16-ft Mills, Grootvlei, January-April 1958."

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NEWSLETTERS . . . . .
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all are included in the special Membership Section, page 230.

MINNESOTA—PITTSBURGH

For a review of two Section meetings, turn to page 277.

Membership Change of Address Personals Data Boxes
page 281

Please tell the Census Bureau what you are . . .

The 1960 Population Census will be conducted as of April 1. Every fourth household will be asked to answer the question, "What kind of work is he doing?" for each person 14 years of age or older.

In order that the statistics on scientific and engineering manpower be developed as accurately as possible, the Census Bureau has asked that we pass along a reminder that this question on occupation should be answered completely and precisely. The entry should consist of at least two words in most cases.

Some examples of acceptable entries are: Engineer, mine development; metallurgical engineer, stress; metallurgists; mining engineer; mining engineer, design; safety engineer, mining; petroleum engineer; processing metallurgical engineer.

New United Engineering Center work has commenced. Snow proves no deterrent to progress as workmen put up concrete forms for the pouring of cement. For a report, see page 276. (Photo by Harriet King, ASME.)

MEETINGS, Past, Future

Utah Section annual "Revue," page 279

Last minute details on the **AIME Pacific Northwest Regional Meeting,** April 28, 29, 30, Portland, Ore., are given on page 276.

Moab in May p. 276

Mineral Information Section Begins On Page 198

SME AVAILABLE PREPRINTS ANNUAL MEETING PAGE 243

Uranium Section Holds Annual Moab Session

The annual Uranium Symposium, sponsored by the Uranium Section, will be held Friday May 6 and Saturday May 7 at Moab, Utah. Friday morning will be devoted to registration followed by a welcoming luncheon at noon. The afternoon will be given over to a general technical session. A banquet will be held Friday evening.

Saturday morning there will be another general session; in the afternoon separate forums will be held for mining, metallurgy, and geology. The Symposium, as usual, will end Saturday evening with a chuck-wagon dinner and blow-out at the home of Charles Steen.

Field trips are scheduled for Sunday: one through the new carbonate circuit of the Uranium Reduction Co. mill in Moab, and, if a sufficient number of people desire, field trips through some of the mines in the Big Indian District. Plans are also being made for boat trips down the Colorado River canyon.

New United Engineering Building Progress Told

Excavation for the new United Engineering Center in New York started December 14 and had been completed by the beginning of February. Concrete is being poured in the basement wall; major contracts have been let including excavation, structural steel, skin, granite, plumbing, electrical work, cut stone, elevators, and heating and air-conditioning. There is a reasonable hope that the building will be finished in the spring of 1961, ready for occupancy about July 1, 1961.

About a year ago the site was cleared and exemption from real estate taxes secured. The construction contract was signed in May; working drawings were completed on September 2; carefully selected contractors submitted their bids on October 2. The structural steel contract was let November 1. The contractor was not only low in price but also had a rolling schedule which he made available for the Center. About one third of the steel tonnage is now in the fabricator's shop and it is expected that the erection of steel will start May 1.

The construction contract is on a fixed fee guaranteed-limit-of-cost basis. On December 1 agreement was reached on a guaranteed-limit-of-cost of 8,042,000 for a stainless steel spandrelite building. Turner Construction Co. pays any excess over the guarantee-limit-of-cost and UET receives 75 pct of any saving made less than the guarantee-limit-of-cost.

The cost of this project is approximately $12,000,000, of which

$8,000,000 will be required for the building and about $2,800,000 has been spent for the site, the remainder to be needed for architect's fee, building equipment, insurance during construction, legal and accounting fees, and contingencies.

The funds for the new Center will be derived from 1) the Depreciation Fund and from the sale of the present building from which it is hoped to net something over $3,000,000; 2) Industrial Gifts Campaign, with a goal of over $5,000,000, of which $4,772,000 has been subscribed by 568 companies; 3) the Member Gifts Campaign in which 11 societies are joining with an agreed upon combined quota of $3,787,000, of which on Jan. 31, 1960, $2,977,000 had been subscribed by nearly 64,000 members. AIME members' contributions to February 5 totaled $352,503, or 70.5 pct of its $500,000 quota. This amount came from 5,799 members, or 17.5 pct of the membership of 33,378 on Dec. 31, 1959, excluding students.

Metalmen, Miners Will Convene in Portland

The Pacific Northwest Metals and Minerals Conference will be held April 28, 29, and 30 at the new Sheraton Hotel in Portland.

Registration will take place from 8:00 am to 5:00 pm Thursday and Friday. A special program has been arranged for the ladies. Industrial movies will be shown each morning from 8:00 to 9:00; several *quickie* tours as well as field trips have been arranged. The program follows:

THURSDAY, APRIL 28, AM

9:00-11:30

Refractories for the Aluminum Industry

Charles McVicker, *Chairman*

Evaluation of High Alumina Brick for Aluminum Melting Furnaces: *J. E. Lorenz*, Kaiser Aluminum & Chemical Corp.

Properties of Special Refractories with Regard to Their Use in the Aluminum Industry: *W. L. Peskin*, The Carborundum Co.

(Continued on page 278)

Pittsburgh and Minnesota Sections Hold Fall and Winter Meetings

Carl Winters, educational consultant to General Motors Corp. and principal speaker at the Minnesota Section banquet, January 11; N. A. Moberg, 1960 chairman of the Section; and Robert J. Linney, Section past-president, were snapped as they examined the pin (not shown) presented to Mr. Linney for his outstanding leadership of the Section in 1959. Mr. Moberg made the award presentation. Mr. Linney also received the AIME Saunders Medal recently in New York. At right are several mineral industry leaders who attended the Duluth meeting. From left to right are Hugh J. Leach, the Cleveland-Cliffs Iron Co.; R. H. B. Jones, U. S. Steel Corp.; R. L. Bennett, Oliver Mining Div., U. S. Steel; and Kenneth Duncan, now retired, formerly at Pickands Mathers.

Tom Regan, Consolidation Coal Co., addresses the Mineral Industry Group on the subject of coal pipe line development.

Pittsburgh Convenes At Off-the-Record Meeting

About 940 coal, oil, gas and steel engineers attended the 14th annual Off-the-Record meeting of the Pittsburgh Section on November 6 at the Penn-Sheraton Hotel, Pittsburgh.

During the Fellowship dinner, a number of awards were presented: a plaque commemorating Pittsburgh's Bicentennial to J. H. Henderson, Section chairman; the F. L. Toy award to Earl J. Hohman, student paper prize to E. Fortner, and the Reinartz Scholarship to T. McGough.

Dr. Clifford Furnas, chancellor, the University of Buffalo, was the featured speaker at the dinner; his topic was *Population Explosion.*

During the day-long technical sessions (ten in all), about 40 papers and films were presented.

Photographic coverage was provided for the Section by Charles Brown, photographer of Universal-Cyclops Corp.

Students from three universities and six high school science teachers were special meeting guests.

Weather Helps Attendance at Duluth Meeting

An absence of January storms and good traveling conditions aided an attendance of over 625 at the Annual Meeting of the Minnesota Section held in Duluth on January 11. In addition, the ladies auxiliary, under the direction of Mrs. R. J. Linney, reported an attendance of about 180.

The all-day meeting started with the Section's annual business meeting in the morning, and followed with the noon luncheon, afternoon program, and banquet.

R. J. Linney, 1959 Section Chairman, introduced special luncheon guest, J. L. Gillson, now 1960 AIME President. Speaker was De Loss Walker. Banquet speaker that evening was a world-traveling clergyman, Carl S. Winters, who commented upon a recently completed 40,000-mile trip which took him to such countries as Japan, Thailand, India, England, and France. Another feature of the evening was the presentation of membership awards and a pin to R. J. Linney for his outstanding leadership of the Section in 1959.

New Minnesota Section officers are: Norman A. Moberg, Oliver Iron Mining Div., U. S. Steel Corp., *chairman;* Edwin R. Tyler, Pickands Mather & Co., *first vice chairman;* Fred Bunge, The M. A. Hanna Co., *second vice chairman;* E. P. Pleider, University of Minnesota, *third vice chairman;* and W. F. McDermott, Erie Mining Co., *secretary-treasurer.*

The technical part of the meeting was devoted to the general topic of economics of the mining industry. One speaker pointed out that, in order to meet competition from other sources, the industry must utilize machinery as much as possible to replace manpower. Current labor costs could be *frozen* by such use, in spite of the rising trend in labor costs.

The meeting was, in actuality, a three-day one, for the annual Mining Symposium of the University of Minnesota followed on January 12 and 13 in Duluth.

The symposium topic this year was iron ore, and the program covered such aspects as ore economics, future techniques in iron and steel, ore developments in Canada, the potential of ore in South America, the competitive position of Lake Superior ore, and a general economy summary as the program closing.

Head table guests at the Pittsburgh fellowship dinner are left to right: T. McGough, D. Johnson, R. W. Smith, D. Laughrey, R. W. Shearman, J. L. Gillson, R. Barnhart, Clifford Furnas, G. L. Fitterer, J. H. Henderson, Howard C. Pyle, J. H. Melvin, E. O. Kirkendall, R. Shrut, J. B. Alford, J. C. Fox, C. Potter, E. Fortner, and C. L. Turner. Mr. Barnhart was toastmaster and G. L. Fitterer introduced Dr. Furnas.

Pacific Northwest

(Continued from page 276)

9:00-11:30

Geology

Fay W. Libbey and
Lloyd Staples, *Chairmen*

Geology of Lakeview, Oregon, Uranium Area: *Norman L. Peterson*, State of Oregon Dept. of Geology and Mineral Industries.

Recent Developments in the Mining Laws: *Irving Rand*, attorney.

Scenes of Helicopter Mineral Exploration in Alaska: *John P. McKee*, Fremont Mining Co.

Structural Control of Alpine Mineral Deposits: *Elmer A. Walter*, University of Oregon.

9:00-11:30

Metals Branch Extractive Metallurgy—Process (In Cooperation with AMS)

Emmons Coleman, *Chairman*

The Current Status of the Direct Reduction of Iron Ore: *H. W. Lownie, Jr.*, Battelle Memorial Inst.

Recent Developments in the Strategic-Udy Processes: *Murray C. Udy*, Strategic-Udy Processes Inc.

Production of Ferronickel at Riddle, Oregon: *Emmons Coleman*, Hanna Nickel Smelting Co. and *D. N. Vedensky*, The Hanna Mining Co.

Recovering Alumina from Ferruginous Bauxite: *Lloyd H. Banning*, USBM.

THURSDAY, APRIL 28, PM

12:00 noon

Luncheon

Speaker: *E. C. Babson*, manager of foreign operations, Union Oil Co.

1:30-4:30

Refractories for the Aluminum Industry

Charles McVicker, *Chairman*

The Effect of Operating Variables and Practices on Refractory Life in Aluminum Melting Furnaces: *James E. Dore*, Olin Mathieson Chemical Corp.

Refractories for the Carbon Bake: *C. F. Wenrich*, Harbison-Walker Refractories Co.

The Effects of Processing and Composition Variables on Refractories Use in the Aluminum Industry: *W. J. Meid*, Engineered Ceramics.

1:30-4:30

Geology

Fay W. Libbey and
Lloyd Staples, *Chairmen*

Pacific Northwest Oil and Gas Exploration: *Robert J. Deacon*, Northwest Oil Report.

Research at P. P. & L. in the Natural Resource Field of the Northwest: *James B. Ward*, Pacific Power & Light Co.

IBM Processing of Mine Assay Data: *George S. Koch, Jr.*, and *Richard F. Link*, Oregon State College

Aerial Mapping and Construction of Topographic Maps: *Leonard Delano*, Delano Studios.

1:30-4:30

Metals Branch Iron and Steel (New Fabrication Techniques)

Harry Czyzewski, *Chairman*

Keynote address: *Carleton C. Long*, President, The Metallurgical Society of AIME.

Explosive Impact Hardening of Manganese Steel: *S. S. Jenkins, Jr.*, E. I. du Pont de Nemours and Co.

Recent Studies in the Explosive Working of Metals: *John Pearson*, U. S. Naval Ordnance Test Station.

Latest Developments in the Chemical Milling Field: *James D. Barton*, Turco Products Div.

4:30-6:30

Plant Tour Omark Industries

8:00-10:00

Reception

Portland Art Museum

FRIDAY, APRIL 29, AM

9:00-11:30

Gold

Pierre Hines and
Evan Just, *Chairmen*

Review of the Gold Problem by World and Countries, and Relationship to Gold Production and Reserves: *Donald H. McLaughlin*, Homestake Mining Co.

Gold in International Payments Today: *M. A. Kriz*, First National City Bank of New York.

The Problem of Gold Convertibility: *O. K. Burrell*, University of Oregon.

9:00-11:30

Industrial Minerals

Tom Waters, *Chairman*

Percentage Depletion: *Glen R. McDaniel*, Hoskins & Sells.

Facilities, Imports and Exports of the Commission of Public Docks: *Thomas Guerin*, Portland Commission of Public Docks.

Manufacture of Lime in East Oregon: *Hans Leuenberger*, Chemical Lime Company.

9:00-11:30

Metals Branch Physical Metallurgy (Melting and Casting of Exotic Metals) (In Cooperation with AMS)

O. G. Paasche, *Chairman*

The Production of Refractory Metals Using the Electron-Beam Melting Technique: *E. F. Baroch*, Wah Chang Corp.

Dingot Quality Vacuum Remelted Uranium Metals from Ceramic Coated Graphite Crucibles: *J. C. Tverberg*, General Electric Co.

A Laboratory Casting Furnace for High Melting Point Metals: *P. G. Clites* and *E. D. Calvert*, USBM.

A Liquid Cooling System for Consumable Electrode-Arc Furnaces: *D. E. Cooper* and *E. Don Dilling*, Titanium Metals Corp. of America.

FRIDAY, APRIL 29, PM

12:00

Gold and Money Luncheon

Speaker: *Philip Cortney*, president, Coty Inc.

Subject: *Monetary Policy and the Price of Gold.*

1:30-4:30

Experts' Panel on Gold

Panel Moderator: *Evan Just*, Stanford University.

Participants: *Oscar L. Altman*, International Monetary Fund; *O. K. Burrell*, University of Oregon; *Philip Cortney*, Coty Inc.; *M. A. Kriz*, First National Bank of New York; *Donald H. McLaughlin*, Homestake Mining Co.; *V. C. Wansbrough*, Canadian Metal Mining Assn.

Summary: *Oscar L. Altman*

1:30-4:30

Industrial Minerals

Tom Waters and
Eugene Andrews, *Chairmen*

Beneficiating Coquille, Oregon Beach Sands: *J. E. Hunt*, Carpco Manufacturing Co.

Gypsum Deposits Along the Great Northern Railroad in Central Montana: *Thomas P. Wollenzien*, Great Northern Railroad.

Industrial Mineral Potential of the Northwest: *Richard M. Foose*, Stanford Research Inst.

1:30-4:30

Metals Branch Iron and Steel (Heat Resistant Alloys)

William Rice, *Chairman*

Classification and Application of Heat Resistant Alloys: *E. A. Schoefer*, Alloy Castings Inst.

Heat Resistant Alloy Properties: *Dean Burgan*, Electric Steel Foundry Co.

Fabrication of Heat Resistant Alloys: *M. D. Bellware*, International Nickel Co. Inc.

6:00-7:00

Cocktail Party

7:00-8:30

Banquet

Speaker: *Joseph L. Gillson*, AIME president, will give an illustrated talk on Pre-Columbia Ruins.

9:30-11:30

Dancing

SATURDAY, APRIL 30, AM

9:00

Field Trip

Tour of the Port of Portland docks.

"The Roaring Twenties" entire cast line up for the finale of the 1960 Miners Revue of the WAAIME and Utah Section.

Twenties Roar Again In Salt Lake City As Miners Stage A Revue

The "Roaring Twenties" boomed again in Salt Lake City on February 6 when the AIME Utah Section together with the WAAIME held their 4th annual Miners' Revue at the Prudential Federal Savings Auditorium.

Under the capable direction of Bill Allison, producer, the show was made up of ten acts, featuring songs and dances popular in the 20's and pantomime acts and impersonations of great entertainers of the period. Altogether 48 Section and WAAIME took an active part, either as performers or behind the scenes as the "stage crew." Festivities included dinner and dancing.

S. S. Alderman, Jr., was entertainment committee chairman. Other stage hands were R. L. Dean, assistant director and producer; Mrs. P. H. Ensign, musical director; Mrs. E. L. Anderson and Mrs. Wayne Burt, casting and acting supervisors; Mrs. R. L. Dean, costume director; Mrs. K. A. Lehner, dance director; E. L. Anderson, stage manager; S. S. Alderman, Jr., props manager; Wayne Burt, lights; Mr. and Mrs. S. D. Michaelson, makeup; Charles Hilton, publicity; and Wayne Brennan, consultant.

Alan Jager and Mrs. K. T. Davis portray Ted Lewis and his shadow (above). Below is Mrs. J. C. Landenberger, Jr., the Utah Section's own Sophie Tucker, in action.

Above, Master of Ceremonies Glen Burt is magnificent in his raccoon coat. Mrs. Harold Felgenhauer (below) is the famous Helen Kane, 20's Boo PoopDedoop Gal.

Bathing beauties are—front row, left to right: Mrs. Alan Jager, William Swiler, Mrs. A. G. Humphries; back row, left to right: Harold Felgenhauer, Mrs. Swiler, A. G. Humphries, Mrs. F. A. Alsop, K. T. Davis. They cavorted at "Saltair," Utah's 20's resort.

Charleston dancers kick up their heels. Glamour gals, left to right are: Mrs. E. K. Olsen, Mrs. Joe Norden, Mrs. K. H. Matheson, Mrs. Clark Wilson. Escorts in boaters and stripes are, left to right: E. K. Olsen, Joe Norden, K. H. Matheson, C. Wilson.

Around the Sections

• The **Washington, D. C., Section** met on January 5 at the Broadmoor to hear Harold M. Bannerman. His topic was *Research and Mineral Supply*.

• The **El Paso Section** held its Christmas dinner-dance December 18 in the Crystal Ball Room of the Hotel Cortez.

• The November 19 meeting of the **Ajo Subsection,** Arizona Section, was held at the Copper Coffee Shop. J. S. Sumner gave an illustrated lecture on the use of geophysical equipment in mining.

• The **San Francisco Section** held its annual Christmas party December 9 at the Engineers Club.

• The November 13 meeting of the **St. Louis Section** was held at the Hotel York where members heard Dr. Schrade F. Radtke, director of research, American Zinc Inst., review some of the research projects his organization has worked on in the last year. At the business meeting the following officers were elected: Gordon M. Bell, chairman; V. W. Buys, vice chairman; and Norman S. Geist, secretary-treasurer.

Underground Storage of Natural Gas was the subject of the December 11 meeting at the Hotel York. Rex Bannister and John E. Thomas, both of the Laclede Gas Co., St. Louis, were the speakers. A film was also shown.

• **The Adirondack Section** reports the following new officers: Severn P. Brown, chairman; George E. Erdman, vice chairman; Patrick F. Farrell, secretary-treasurer; Charles F. Dievendorf, section delegate to fill unexpired term in 1960. Alternate delegate for 1960, Severn P. Brown. Section delegate 1961 and 1962, Severn P. Brown; alternate delegate 1961 and 1962, George E. Erdman.

• The **Chicago Section's** Student's Night was held December 10 at the Chicago Bar Assn. at which R. M. Brick spoke on *The Present and Future Metallurgy of Cans*.

• The October 16 meeting of the **Southwestern New Mexico Section** was a cocktail-dinner at the Murray Hotel. Roger V. Price addressed the gathering on *Looking Beyond the Horizon*.

• Dr. J. L. Gillson, AIME President-Elect for 1960, was guest speaker at the **Oregon Section** meeting December 10 at The Clock, Portland. He spoke on production of titanium minerals throughout the world. The following officers were elected: Francis X. Cappa, chairman; Charles McVickers, vice chairman; and S. L. Sampson, secretary-treasurer.

• The **Connecticut Section** met at the Chase Country Club, Waterbury, November 12 where they heard Joseph F. Gillson speaking on the aims of AIME and James Bechtold speaking on the philosophy of material design.

• November 21 was Ladies Night for the **Morenci Subsection,** Arizona Section, which met at the Longfellow Inn, Morenci. W. P. Schisler showed and narrated a film taken on his recent *Safari in Africa*. The following officers were elected: Charles Sorvisto, chairman; J. B. Stanley, vice chairman and program chairman; F. M. Winkler, secretary-treasurer; and C. C. Riley, chairman of membership and nominating committee.

• The **Lima, Peru, Section** held its October 21 meeting in the America Room of the Hotel Bolivar. John W. Gabelman gave an illustrated lecture on *Alteration as a Guide in Ore Exploration*.

• The **Southwest Alaska Section** held its October 19 meeting at the State Department of Mines Building, Anchorage. Mcham Bell discussed *Public Lands Management*.

• The annual fall dinner-dance of the **Utah Section** was held October 24 at the Prudential Auditorium, Salt Lake City.

• Officers of the **Utah Section** met with Joseph L. Gillson, 1960 AIME President, for luncheon at the University Club during his brief stop in Salt Lake City, October 26.

• The **Colorado Section** met at the University Club in Denver on November 19 where Walter L. Crow talked on *Africa Revisited*.

• The **Upper Mississippi Valley Section** reported the election of the following new officers: D. C. Dixon, chairman; A. A. Jones, vice chairman; H. A. Palmer, secretary-treasurer; W. R. Zwickey, 1961 section delegate; and F. B. Piquette, 1961 alternate section delegate.

• Additional 1960 officers of the **Lehigh Valley Section** are C. F. Eben, treasurer; R. T. Renfrew, secretary; N. Brown 1961-1962 section delegate; and R. W. Sleeman, 1961-1962 alternate section delegate. Committee chairmen are G. A. Perhac, program and publicity; A. T. Kaufman, hospitality; G. K. Biemesderfer, membership; H. J. Brunell and S. A. Ward, student affairs; and N. Brown, nominating. During 1960 the Section will hold the following meetings: a spring technical meeting in March or April; dinner-dance in May or June; a September field trip to the Grace Mine, Bethlehem Cornwall Corp.; October technical meeting and December 2 will be Ladies' Night at the Lehigh Valley Club, Allentown, Pa.

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Personals

L. H. Lange, consulting metallurgist and vice president, The Galigher Co., Salt Lake City, returned in late fall from a consulting trip to the Philippines for Atlas Consolidated Mining & Development Corp.

Lawrence Litchfield, Jr., executive vice president of Aluminum Co. of America, has been elected a director of the company.

Joseph L. Gillson, chief geologist of the Du Pont Co.'s Development Dept., retired February 29. For a full profile of Dr. Gillson, 1960 AIME president, see p. 116 of the February issue of MINING ENGINEERING. He is being succeeded by **Robert M. Grogan,** who becomes manager of a newly formed Geology Div. within the department.


J. L. GILLSON


N. F. KOEPEL

Norbert F. Koepel has been elected to the board of directors of The Anaconda Co.'s two principal subsidiaries operating in South America, Andes Cooper Mining Co. and Chile Exploration Co. He has been vice president of both companies.

F. E. Lewis retired after 20 years with the Cordero Mining Co. He was superintendent at Horse Heaven Mine at the time of his retirement. He recently returned from Hawaii.

The directors of the Chrysler Corp. elected **Robert G. Page** to the board to succeed **Byron C. Foy** who has retired. Mr. Page is president of Phelps Dodge Corp.

Bradford Willard, head of the department of geology at Lehigh University for 20 years retired at the end of the academic year, June 1959.

Hardinge Co. Inc. has named **Charles C. Nolan** western district manager to succeed **R. L. Baldwin** who is retiring. Mr. Baldwin will continue to act in a full time consulting capacity, retaining an office at the western office headquarters in San Francisco. Mr. Nolan has been assistant to the western district manager since 1956.


C. C. NOLAN


H. M. JACOB


P. D. I. HONEYMAN


H. C. WEED

H. Myles Jacob was elected president of Inspiration Consolidated Cooper Co. at a meeting of the board of directors on Jan. 28, 1960. He succeeds **Pharic D. I. Honeyman,** who is retiring. **H. Carroll Weed,** of Inspiration, Ariz., was elected director

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personals

continued

and vice president. He will also continue as general manager of the company.

William B. Hall has been named president of Vitro Chemical Co., a newly formed subsidiary of Vitro Corp. of America. Mr. Hall is vice president of the parent company, a post he will continue to hold.

George Murray recently became assistant general manager of the Giant Cycle Corp., a subsidiary of Golden Cycle Corp. where he had previously served as assistant general manager.

K. Blazewicz, formerly metallurgist for St. Patrick's Copper Mines, Ireland, is at present associated with Noranda Mines Ltd. (concentrator) of Noranda, Que., Canada, where he is engaged in research.

Stanley J. Luft has taken the post of head of the department of geology, Oriente University, Santiago, Cuba. The department has been reactivated with emphasis placed on the economic geology of Oriente Province.

The Utah Mining Assn. elected **Oscar A. Glaeser** president to succeed **Lockwood W. Ferris.** Other officers are: **S. K. Droubay,** first vice president; **F. C. Green,** second vice president; and **Mitchell Melich,** third vice president. **Miles P. Romney** was renamed secretary and manager, and **Walter M. Horne,** assistant secretary and manager.

R. H. HEFFELFINGER

W. G. FREEMAN

Milwhite Mud Sales Co. recently announced the promotion of **R. H. Heffelfinger** to superintendent-production and properties, Gulf Coast area. He was formerly superintendent of the New Orleans plant and will continue to work out of New Orleans. **W. G. Freeman** was promoted to assistant chief engineer-production and properties from mining engineer. He will be based in Houston.

Scott Mahon who had joined the Idaho Dept. of Highways as design engineer upon graduation from the University of Idaho in June 1958, has left to join Phillips Petroleum Co. in July 1959. He started as geologist with Phillips and later transferred to the mine engineering department.

R. L. McCHAIN

D. S. PERMAR

A reorganization of the sales dept. of the Le Roi Div., Westinghouse Air Brake Co. was announced recently. Two new groups have been formed. One is headed by **R. L. McChain** as manager, construction and mining industry sales. **C. L. Meigs** and **N. W. Reinker** have been appointed assistant managers. **D. S. Permar** has been named manager, general industrial sales, and will also continue as assistant general sales manager. **E. R. Couch** takes on the job of assistant manager for industrial sales.

Richard H. Olson has joined the Nevada Bureau of Mines as economic geologist after two years as exploration geologist for Union Carbide Corp.

R. J. Isherwood, until recently doing post graduate work at Imperial College, London University, has joined the Iron Ore Co. of Canada as ore testing and research engineer.

C. A. Botsford, consulting mining engineer, has moved his base of operations from San Fernando, Calif., to Globe, Ariz.

Joe C. Arundale, U. S. Dept. of State, Foreign Service, has been named minerals officer (attaché) American Embassy, Monrovia, Liberia. He was formerly consul (mineral officer and principal officer) in Elisabethville, Belgian Congo. His work involves reporting on economic and technologic aspects of the mineral resources and industries of the area (West Africa).

Effective Jan. 1, 1960, **James A. Briggs** became manager of the New Cornelia Branch of Phelps Dodge Corp. at Ajo, Ariz. He succeeds **Alfred T. Barr** who retired from active service on that date.

American Potash & Chemical Corp. has announced the appointment of **Howard E. Kremers** as district manager of market development with headquarters in New York. He had previously been manager of market development for the company's Lindsay Div.

Charles R. Cox, Kennecott Copper Corp., was elected to a one-year term as a board member of the National Industrial Conference Board

at a recent meeting of the organization.

Louis C. Rhodes, W. Herman Van Houten, and **Arnott J. Lee** were among 13 Joy Manufacturing Co. executives honored at a dinner celebrating lengths of service with the company ranging from 20 to 35 years.

The Bureau of Mines announced the appointment of **Lawrence B. Berger** and **Donald S. Kingery** to new administrative positions. Berger has been transferred from Pittsburgh to Washington, D. C., to become chief of the newly created Div. of Health and Accident Prevention. Kingery, who was chief of the Mine Ventilation Section in Pittsburgh since 1958, will remain in Pittsburgh to head the Health and Safety Research and Testing Center.

Westinghouse Air Brake Co., Le Roi Div., has announced the appointment of three new vice presidents: **R. H. Koehler,** from general sales manager to vice president, sales; **J. R. Gavigan,** from manager of administration and accounting to vice president, planning and administration; and **L. E. Dondero,** from manager of the West Allis, Wis., plant to vice president, manufacturing. Other promotions announced are: **Frank Kuether** to manager of engineering from head of engineering at the West Allis plant; **Al Feucht,** manager of the Cleveland plant to manager of manufacturing for the division; and **John Miller,** formerly in charge of Cleveland plant accounting, to manager of accounting.


R. H. KOEHLER


J. R. GAVIGAN


L. E. DONDERO


R. M. JOHNSON

Robert M. Johnson has become assistant manager of the Foreign Sales Div. of the Fuller Co. He has served as an administrative assistant in the company for the past ten years.

Hugh J. Leach, who has been manager of Michigan iron ore mines for The Cleveland-Cliffs Iron Co., Ishpeming, Mich., since August 1958, was elected vice president–foreign

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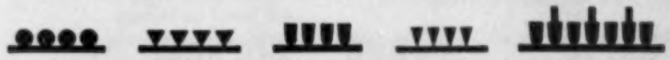

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personals

continued

operations and iron ore development. **Harry C. Swanson** will succeed him as manager of Michigan mines. Swanson was formerly general superintendent of Cleveland-Cliff's mines in Michigan.

Harry E. Nold, who had been engaged in consulting activities since his retirement from Ohio State University as professor of mining engineering in 1954, has been forced to give up his consulting activities because of ill health. He is living in Bradinton, Fla., Box 5602, Trailer Estates, and would welcome visits and letters from his friends.

Richard D. Ellett, formerly geologist with National Lead Co., recently joined the Utah Construction & Mining Co. as project geologist.

Eugene E. Risch has taken a job as miner with Green Mountain Uranium. He had been mine engineer with Hidden Splendor Mining Co.

George K. Williams, who had been with Twining Laboratories of Southern California as geologist until January of this year, has joined American Metal Climax as geologist.

James D. Loghry has become mine geologist for Kermac Nuclear Fuels Corp. He had been field geologist for Newmont Exploration Ltd.

Gordon Ziesing has left The Eagle-Picher Co. where he was a mineral dressing trainee for his stint in the U. S. Army.

Roy J. York, Jr., has left York Mining Ind. where he was plant manager to become unit foreman for the Reynolds Mining Corp. in Arkansas.

Raymond J. Mehle, who graduated from the South Dakota School of Mines & Technology in November 1959 has become assistant geologist with Homestake-Sapin Partners, Grants, N. M.

Edward J. Lee has become process metallurgist at the Gary steel works of U. S. Steel Corp. after 3½ years as mining engineer at Grace mine of Bethlehem Cornwall Corp.

Bruce M. Bertram, former student at Michigan College of Mining & Technology, has taken a job as geological engineer with International Salt Co. Inc., Cleveland mine.

Victor N. Antaki, who for the past 2½ years has been plant manager of U. S. Air Force Plant 74—designed, built, and operated for USAF by Air Products Inc., has been promoted to manager of Operations Dept. Services of Air Products.

William E. Rudolph, former chief engineer of the Chile Exploration Co., received the David Livingston Centenary Medal for "scientific achievement in the field of geography of the Southern Hemisphere" at the American Geographic Soc. dinner at the St. Regis Hotel, New York, in January.

Hansen Associates Inc. of Salt Lake City, a firm of management consultants, began operating the first of this year under the direction of **Don A. Hansen,** president. Mr. Hansen had been with Bear Creek Mining Co. for the past three years as a geophysicist.

R. D. Macdonald, formerly associated with Battelle Institute, Columbus, Ohio, has become vice president in charge of operations for Bonneville Ltd., Salt Lake City.

Charles C. Hathhorn has joined the Bunker Hill Co. in Kellogg, Idaho, upon his return from Guatemala where he had been project manager, Camay R A Minerals, Exploration Div., Grace & Co.

P. I. A. Narayanan, assistant director of the National Metallurgical Laboratory, India, is currently visiting ore dressing plants and laboratories in France and later plans similar visits throughout the United Kingdom.

Richard W. Livingston has left Jones & Laughlin Steel Corp., where he served as chief ore dressing engineer for over seven years, to become chief metallurgist for Duval Sulphur & Potash Co.

The National Coal Assn. announced the appointment of three division heads for its new marketing department: **Carroll F. Hardy,** director of the Bituminous Coal Institute Div.; **Harry C. Ballman,** director of the Air Pollution Control Div.; and **Paul L. Brown,** director of the Manpower Development Div. Mr. Hardy was managing director of BCI before it merged with NCA and Mr. Ballman had been manager of field engineering services of BCI. Mr. Brown was director of training and education for the American Coal Sales Assn. which has merged with NCA.

Christian F. Beukema has been appointed president of Oliver Iron Mining Div. of U. S. Steel Corp. to succeed the late **Rudolph T. Elstad.** For the past five years, Mr. Beukema has been president of U. S. Steel's Michigan Limestone Div. in Detroit. **Carl G. Hogberg** succeeds Mr. Beukema in that post. Mr. Hogberg has been vice president of the Michigan Limestone Div. since 1957.

Russell T. Runnels, head, industrial mining division, State Geological Survey of Kansas, left after 13 years service to join the staff of the Monarch Cement Co., Humboldt, Kans.

Lloyd G. Fitzgerald has been assigned to conduct U. S. Bureau of Mines accident prevention training for the employes at the West Virginia mines of the Pocahontas Fuel Co.

L. E. SCOTT L. G. FITZGERALD

Lewis E. Scott has joined the Arizona Highway Dept. as engineering geologist. For the past four years he had been working in Costa Rica and Guatemala on the Inter-American Highway as materials engineer for the U. S. Bureau of Public Roads.

Dick R. Watkins, formerly mine shift boss for International Minerals & Chemical Corp. has become sales representative for the Spencer Chemical Co.

Tom T. Heywood has joined Mijnmaatschappij in Curacao as assistant manager following a leave in England. He was formerly with Sematam Bauxite Ltd., Borneo, as mine superintendent.

A. Charles King, formerly mineral dressing engineer for Quebec Metallurgical Industries, recently joined Wabush Iron Co. Ltd. as pilot plant foreman. For a short period between these two positions, Mr. King served as assistant metallurgist for New Mylamaque Exploration.

H. K. Porter Co. Inc. announced the appointment of **C. P. Stewart** as manager, trade relations, effective the first of this year. Mr. Stewart, who fills the vacancy left by the retirement of **D. E. Jenkins,** started with Porter three years ago in the trade relations dept.

The following personnel changes have been announced by American Zinc Co. of Tenn., effective January 1: the retirement of **D. B. Grove,** superintendent of the milling department, after 47 years with the company; the promotion of **James H Polhemus,** assistant to Mr. Grove for many years, as superintendent of the milling department; and the appointment of **James P. Snider,** metallurgist, as assistant superintendent.

Lloyd S. Campbell has been appointed vice president of Michigan Limestone, a division of U.S. Steel Corp. Prior to this, Mr. Campbell has been assistant to the vice presi-

dent of operations of Oliver Iron Mining, another division of U.S. Steel, at Duluth.

Richard F. Goodwin has joined Cerro de Pasco Corp. to serve as a mining consultant. Initially he will devote his efforts exclusively to Cerro's Rio Blanco, Chile, project, a copper property still in the preliminary development stage. Mr. Goodwin had been serving as a director and chairman of the executive committee of Southern Peru Copper Corp. before joining Cerro.


R. F. GOODWIN


V. D. PERRY

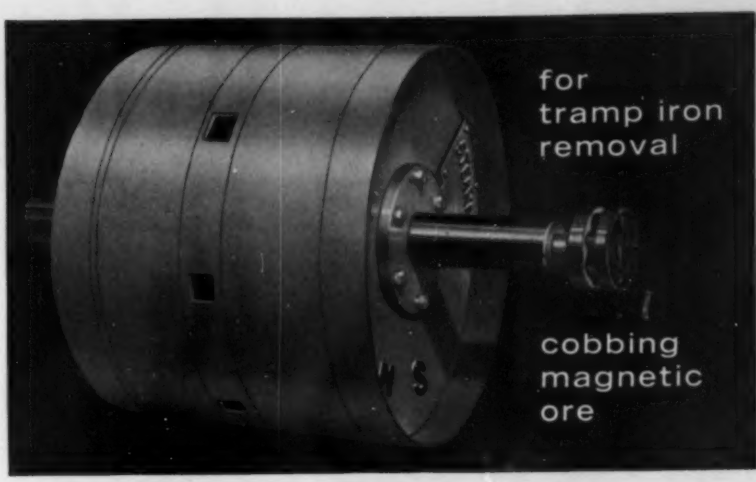
The Anaconda Co. announced the election of **Vincent D. Perry** to the board of directors of Greene Cananea Copper Co., a 99 pct-owned subsidiary. Mr. Perry has been associated with Anaconda's mining and geological activities since 1922 and has been vice president and chief geologist of The Anaconda Co. since 1957. In his new post he succeeds **Russel B. Caples** who has retired.

Christian H. Aall has been appointed vice president of the Amco Div. of American Metal Climax Inc., responsible for the division's copper and zinc smelting and refining operations. Prior to this he was director of research for the Division. At the same time **A. E. Lee, Jr.**, was appointed technical director of the division succeeding **Douglas Tennant** who will retire on June 30, 1960. Mr. Lee formerly was in charge of the division's zinc smelting and refining operations.

P. J. Shenon has taken a leave from his consulting business in Salt Lake City to teach geology at Stanford University during the academic year 1959-1960. He is filling in for Dean Charles F. Park, Jr., who is on leave. Mr. Shenon expects to return to Salt Lake City early in June. He has been elected president of the Soc. of Economic Geologists for 1961.

Richard B. Wells who had been well logging geologist for Core Laboratories has become chief geologist, Michigan Div., in charge of operations in the Michigan area where they are investigating the possibility of an eastward extension of the new Michigan oil field.

Hollis G. Peacock has been named to fill the post of chief geologist with Utah Construction & Mining Co. with headquarters in San Francisco. Prior to this appointment, he had been an independent mining consultant.



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Modern mining techniques have brought tremendous increases in output per man-hour. In order to capitalize on this increased output, processing operations have been speeded up to the maximum. Stearns electromagnetic pulleys are designed to take these additional demands in stride — assuring positive separation of ferrous materials from the heaviest loads at belt speeds as high as 600 fpm. Just as important, they cost no more than ordinary "weak-link" pulleys.

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Obituaries

Albert W. Hahn

An Appreciation By
O. N. Friendly

The passing of Albert W. Hahn (Member 1917) in San Francisco on Oct. 24, 1959, marked the closing of a life of endeavor and usefulness to the mining fraternity.

A graduate of Columbia University, class of 1905, a member of the Institute since 1917, Mr. Hahn devoted his life to research and the operations of metallurgical plants throughout the United States, Canada, Mexico, and Russia. The years from 1906 to 1915 were spent guiding metal processes in Mexico.

Early in his career he was employed by the late John Hayes Hammond and was for many years his trusted metallurgical engineer. Mr. Hahn in association with Professor E. J. Hall was a pioneer in the basic patents. Along with Professor Hall he organized the Metal Disintegrating Co., the foremost developer of the powdered metal process. Shortly after World War I he was employed by the Russian government as its consulting metallurgical engineer, and spent considerable time throughout Russia getting them started in their milling and metallurgical processes.

For the many years between 1923 and 1936 his offices and headquarters were in Salt Lake City where he was consulting engineer for numerous operating companies. While in Salt Lake City he developed new processes and uses for powdered lead, and in 1936 moved to San Francisco and headed the Metalead Products Corp. and built its factory near Palo Alto.

He retired a few years ago to devote his time to the fruits of his labors. The business of mining has gained because he lived; his integrity, energy, and objective thinking made him an ornament to his profession. He leaves a wife who has been his lifetime companion and a host of friends to mourn his going.

Theodore Page

An Appreciation By
W. H. Keener

Theodore Page (Member 1940) was born near Los Angeles on Jan. 16, 1900, and died in Ajo, Ariz., Nov. 11, 1959.

Ted moved with his family to Bisbee, Ariz., in 1915 where he was an outstanding football player and an officer in the Bisbee High School Cadet Corps. Near the close of World War I, Ted found the call to service irresistible, and he quit high school to enlist in the Navy; after serving his enlistment, he returned to Los Angeles where he completed his high school education.

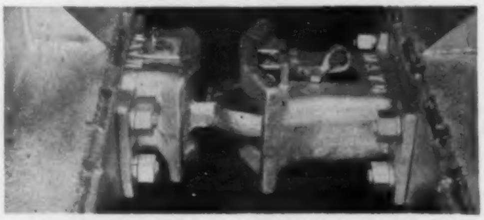
Ted enrolled at the University of Arizona in 1922 where he affiliated with the Phi Delta Theta fraternity. Directing his studies towards English literature and education, Page was active on the school publicaton where he was liked and respected by all who came in contact with him. It was probably Ted's intention to enter the teaching profession, but after a few short periods of substituting, he decided that teaching was not for him.

Early in 1929, Ted returned to the Bisbee district where he entered the metallurgical field in the Test Dept. of the Warren concentrator. In 1934, Page moved to Ajo to work at the New Cornelia Branch of the Phelps Dodge Corp. where he soon became mill shift foreman, the duties of which he faithfully and energetically performed for the rest of his life except for 36 months when he returned to Navy Service during 1942-1945.

In Ajo, Page capably served as an officer of the Ajo Subsection, Arizona Section, of AIME.

Ted's fearlessness and determination in the face of overwhelming adversity will serve forever as an example to those who knew him best.

NEW, SAFE and AUTOMATIC



Mayo Mine Car Coupler

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Mayo's new, cast steel coupler for narrow gauge mine cars couples instantly on tangent or curves. Safe, self-centering link completely eliminates all hazards of hand couplings. Only a little more expensive than link-and-pin, it more than pays for itself by preventing accidents. If you can save one smashed finger, you've got these couplers paid for. Easily installed by bolting to existing cars. Write for Bulletin No. 21.

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Student Chapter, Faculty Sponsor, Local Section
or Prof. A. W. Schlechten
The University of Missouri,
School of Mines and Metallurgy,
Rolla, Mo.

John M. Bush (Member 1932) passed away on July 4, 1959, in Ann Arbor, Mich. where he had been living for the past two years. He was born in Canada and worked in Michigan most of his life. He was superintendent for several operations and served for 25 years as manager of the lands and timber department of the Cleveland Cliffs Iron Co.

Leslie W. Householder (Member 1945), former president of Whiteman & Co., passed away on July 12, 1959, at the age of 75. He had been born in Ohio where he graduated in 1904 from Ohio University. Various positions, such as construction engineer for General Electric Co. and electrical and mechanical engineer for Rochester & Pittsburgh Coal Co., prepared him for the job of chief engineer for the latter firm. After 14 years with the firm he left his position as vice president to take over Whiteman & Co. Inc. in Indiana, Pa. For many years he was a member of the wage scale committee of the Central Pennsylvania Coal Producers Assn.

Robert Livermore (Senior Member 1923), retired vice president of North American Mines, Inc. which he founded, died on Sept. 26, 1959, in Boston. A graduate of both Harvard and Massachusetts Institute of Technology, he had wide mining experience including muleback explorations in Colorado and Nevada, management of a mining company in Ontario, and his position as vice president and director of the Calumet and Hecla Copper Co. He also served in World War I and worked in the steamship business in New York.

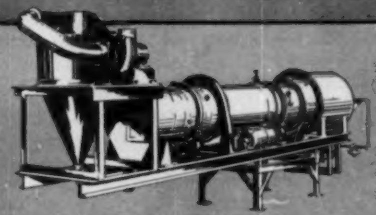
Adelbert H. Richards (Member 1916) died in Salt Lake City on Aug. 30, 1959. He had been metallurgical engineer for 42 years with American Smelting & Refining Co., retiring in 1941. He then was appointed head of the War Production Board office in San Francisco and was a consultant for the U. S. Tin plant at Galvaston, Texas.

James A. Rigg (Member 1943) passed away on Sept. 21, 1959, after a long career of service with Acme Limestone Co. in Fort Spring, W. Va. Beginning in 1916, he was general manager in charge of engineering for the company. At the time of his death he was president, treasurer, and a member of the board of directors of the firm.

Churchill G. Sheldon (Member 1945), retired sales engineer for the Ingersoll Rand Co., died on Sept. 16, 1959. He had worked for Chino Copper Co. in New Mexico and the Mesabi Iron Co. in Minnesota and

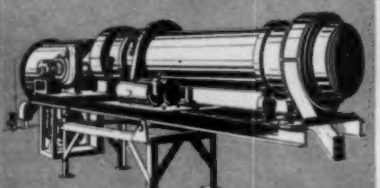
Pilot Plant or Laboratory Equipment . . .

for DRYING



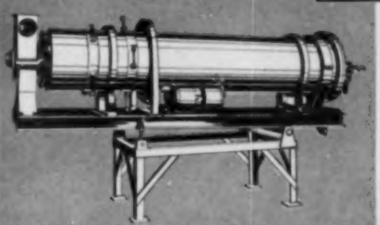
SINGLE-SHELL DRYER

Single-shell, direct gas fired rotary dryer. Arranged for either parallel or counter-flow operation. Mounted on structural steel base. Has removable "knockers." Bulletin AH-471.



DOUBLE-SHELL DRYER

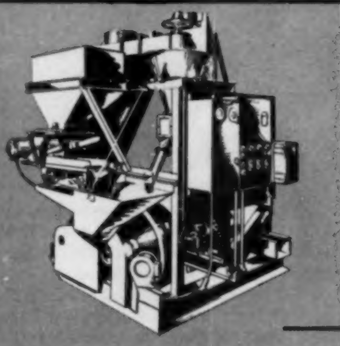
Double-shell, indirect-heat, gas-fired dryer for drying without contamination. Volatiles removed with only limited dilution. Shell rotation speed and shell slope easily changed. Bulletin AH-472.



STEAM TUBE DRYER

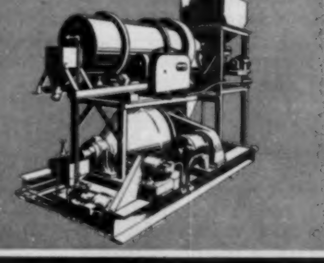
Steam-tube indirect heat dryer. Can be connected to any available steam supply or furnished with a 3-HP steam generator. Available in stainless steel or other corrosion-resistant materials. Easily moved from place to place. Bulletin AH-473.

for GRINDING AND CLASSIFYING



DRY GRINDING UNIT

Make power connections only and the Hardinge Dry Grinding Unit is ready to perform. Self-contained and portable, 7' 8" high. Complete with Constant-Weight Feeder, Conical Mill, "Gyrotor" Classifier, dust collector, product collector and "Electric Ear" grinding control. Bulletin AH-448.



WET GRINDING UNIT

Power and water connections only are needed to put the Hardinge wet grinding unit into operation. Self-contained and portable, 6½' high. Includes Conical Mill, Counter-Current Classifier, launders, feeder, pump and "Electric Ear" grinding control. Bulletin AH-448.

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was chief engineer for the Munro Iron Mining Co. Born in Michigan, he graduated in 1916 from Michigan College of Mines. He served with Ingersoll Rand for over 25 years.

Sergei E. Zalenkov (Member 1936), assistant manager of the northwestern mining department of the American Smelting and Refining Co. died on Aug. 16, 1959. Most of his professional life had been spent with Asarco. Born in Petrograd, Russia, he received his early education there and graduated from Colorado School of Mines in 1936. He spent several years in Peru as manager of operations of the Northern Peru Mining & Smelting Co. before assuming his job with Asarco in Wallace, Idaho, in 1955.

Estey Arol Wentworth (Member 1944), native of New Brunswick, Canada, has passed away. He had attended Horton Academy, Acadia University, and the University of Toronto, receiving an M.A. there in 1932. He began as a teacher at a boys' farm and training school in Shawbridge, Quebec, and after a few years was sub chief on a Canadian Geological Survey Party. From 1942 on he was geologist for Eldorado Mining and Refining Ltd., at Port Radium in the North West Territories and Alberta. In the '50s he worked for many firms in the Yukon, Saskatchewan, and Quebec.

Basil Dorn (Member 1957) was killed in a mining accident while working for Fabulosa Mines Consolidated in La Paz, Bolivia, in October 1958. He had been born and raised in Germany and before joining Fabulosa he was mine manager of Chivicato and Chockorosi mines, also in Bolivia.

Harry G. Kennedy (Member 1943), native of West Virginia, has passed away. He was born in Coal Run, W. Va., and graduated from West Virginia University in 1928 with B.S.-E.M. and M.S.E.M. degrees. The next four years were spent with Carbon Fuel Co. in Cincinnati as combustion engineer and in 1932 he became labor commissioner and assistant secretary of the Kanawha Coal Operators Assn.

Kellogg Krebs (Member 1925), president of Equipment Engineers Inc., died Aug. 25, 1959. He worked for many years for American Cyanamid & Chemical Corp., as field engineer and assistant resident manager. Before that he was employed by Braden Copper Co. in Chile and a variety of firms in the western states. He was born in Kansas City, Mo., and attended California Inst. of Technology and the University of California College of Mining, receiving a B.S. degree in 1923.

Harold C. Lusk (Member 1946) of the Harold C. Lusk Co., sales and engineering, died on Mar. 10, 1959. He was born in Pennsylvania and educated at Pennsylvania State College, receiving a B.S. degree in 1927. He began his career with General Electric Co. as student engineer and application engineer, then joined the Pennsylvania Dept. of Welfare in 1933 on an engineering survey. In 1944 he became district manager of Barrett, Haentjens & Co.

Irving B. Crosby (Member 1928) died Sept. 18, 1959. He was born Jan. 4, 1891, in Boston, Mass., where he received his education first at the Massachusetts Inst. of Technology and later at Harvard. He also attended Columbia University. He was a consulting geologist throughout his professional career, specializing in the geology of dam sites. At the time of his death he had his own business in Boston.

Carl. S. Elayer (Member 1947) died Oct. 17, 1959 at Silver City, N.M., where he carried on his own mining and leasing business. He was born in Salem, Mo., May 12, 1890. He attended Missouri School of Mines, then went to work for the Copper Queen Construction Co. Subsequently he held many mining jobs throughout the country until going into business for himself in 1942.

Kenneth E. Hamblen (Member 1937) died recently in Portland where he had been a consulting mining engineer, prominent in the industry for his part in the development of several important Oregon mining properties. For several years he was on a federal advisory board for procurement of strategic minerals. Mr. Hamblen was born July 20, 1900, in Fall River, Mass. He received his professional education at the Oregon School of Mines from which he graduated in 1922.

Perry G. Harrison (Member 1915), 74, internationally known mining authority and a director of The Hanna Mining Co. died Nov. 11, 1959, after an illness of several weeks. He was associated with several iron ore and gold mining companies in this country and Mexico and was president of Evergreen Mining Co. when it was purchased by The M. A. Hanna Co. in 1946. He moved to Cleveland at that time, serving as vice president of Hanna Mining and ore sales manager of The M. A. Hana Co. until his retirement in 1957. He was also a director of Wheeling Steel Corp. Mr. Harrison was born in Minneapolis. He was a graduate of Columbia University and of the Michigan College of Mines.

Carlton D. Hulin (Member 1919) died Oct. 8, 1959, in Berkeley, Calif. He was born in Eugene, Ore., July 6, 1896, graduated from the College of Mining, University of California in 1920. Most of his professional career was spent in teaching geology at the University of California, where he rose to the rank of Associate Professor, and as a consulting geologist.

Robert F. Manahan (Member 1911) died June 30, 1959. He was born Dec. 10, 1878, in Boston, Mass. He received his A.B. from Harvard in 1900; his S.B. from the Massachusetts Inst. of Technology, 1903. At the time of his death he was living in El Paso.

Walter L. Penick (Member 1936) died in San Francisco, Nov. 10, 1959, after a short illness. He was primarily active professionally in the nonferrous mining and metallurgical industries. For the past 23 years he was manager of the San Francisco office of the Western Precipitation Div. of Joy Manufacturing Co. Mr. Penick was born in Montreal in 1890. He received his professional training at Ohio State University and Washington State College.

Charles A. Week (Legion of Honor Member 1897) died Nov. 2, 1959, at the age of 88 after a long illness. A native of Eureka, Calif., he graduated from the mining department of the University of California with the class of 1894. His mining career took him to Alaska at the turn of the century, although much of his professional activity was centered in the California area.

Hedley N. Whitford (Member 1951) died Oct. 13, 1959, in Cannington, Western Australia. A metallurgist, he had been with Australian Blue Asbestos before his death. In the course of his professional career he had worked in Burma and Tasmania. Mr. Whitford was born in Bendigo, Vict., Australia, Aug. 11, 1901, and graduated from the Bendigo School of Mines in 1922.

John D. Bradley Member 1930) was killed Nov. 26, 1959 in a head-on collision on the freeway from San Francisco to his home in Hillsborough. His wife was also killed in the accident. Mr. Bradley was president of the Bunker Hill Co. where both his father and father-in-law had been president before him. He was born Oct. 26, 1910 in San Francisco and was educated at the University of California School of Mines. Upon graduation he became underground surveyor in the Bunker Hill Mine and continued to be actively engaged in the mining field until the day of his death.

Fred Staats (Member 1950) died Sept. 25, 1959 in Salt Lake City where he had been born 70 years before. He attended the University of Utah for a year then went to work for his father who was a building contractor. In 1928 he became owner and operator of a manganese mine outside of Delta, Utah, and in 1949 transferred his operations to the area outside of Lund where he was producing fluospar.

Necrology

Date Elected	Name	Date of Death
1940	Gordon Barbour	1958
1928	Samuel B. Kanowitz	Dec. 29, 1959
1958	John B. Mitchell	November 1959
1940	Theodore Page	Nov. 11, 1959
1897	Bradley Stoughton (Legion of Honor)	Dec. 30, 1959
1946	L. A. Tillotson	Dec. 27, 1959
1919	F. A. A. Van Gogh	May 28, 1959
1940	Wm. R. Wardner, Jr.	Unknown
1899	Orvil R. Whitaker (Legion of Honor)	Nov. 26, 1959

Membership

Proposed for Membership

Society of Mining Engineers of AIME
Total AIME membership on Jan. 30, 1960, was 33,642; in addition 2,461 Student Members were enrolled.

ADMISSIONS COMMITTEE
A. E. Weissenborn Chairman; Frank A. Ayer, Vice Chairman; R. T. Lassiter, Charles H. Lambur, Alfred D. Rood, William J. Rude, L. P. Warriner.
The Institute desires to extend its privileges to every person to whom it can be of service, but does not desire as members persons who are unqualified. Institute members are urged to review this list as soon as possible and immediately to inform the Secretary's owce if names of people are found who are known to be unqualified for AIME membership.

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Ned D. Cherry, San Francisco
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Leonard E. Johnston, Hoyt Lakes, Minn.
Thomas H. Jones, Jr., King of Prussia, Pa.
Abe M. Kalaf, Phoenix, Ariz.
George Kalaf, Phoenix, Ariz.
John McCreedy, Copper Cliff, Ont.
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Robert E. Daly, Lima, Peru
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CHANGE OF STATUS

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Frank E. Birch, Chandalar, Alaska
Bart Cox, Guelph, Ont., Canada
John W. Donaldson, Downsview, Ont., Canada
Walter R. Guggenheimer, Morococha, Peru
Charles P. Seel, Tuscon, Ariz.
John M. West, Spokane

Junior to Member

Byrd L. Berman, New York
Franz J. Budin, Schneedoerflweg, Austria
Derek J. Ottley, London, England

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Member

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Karl K. Kincell, Fairmont, W. Va.
Emil J. Servant, Coalwood, W. Va.

Junior

Milton J. Barnett, New York

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George W. Lockin, Wheelwright, Ky.
Howard B. Nicholas, Douglas, Ariz.
Frank B. Price, Denver

Student to Member

Elbert T. Bond III, Tarco, Mexico
Harold Davis, New York
Lawrence A. Garfield, White Pine, Mich.
Arnold R. Knutson, Duluth
Dean Nicholson, Grand Junction, Colo.
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Ikram ul-Haq Dar, Rolla, Mo.

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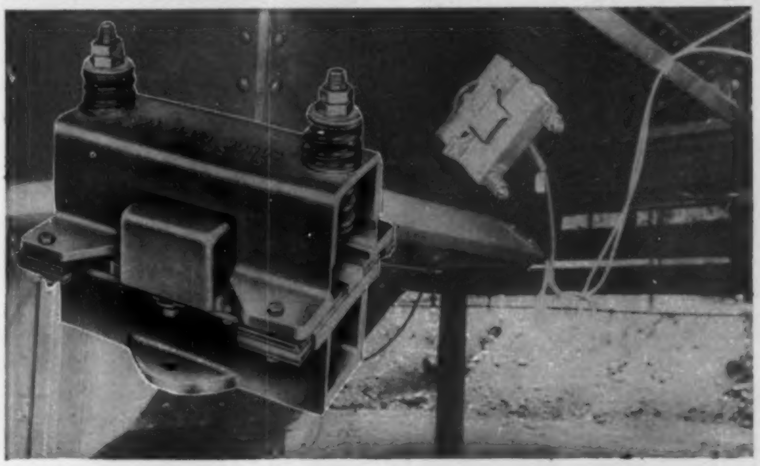

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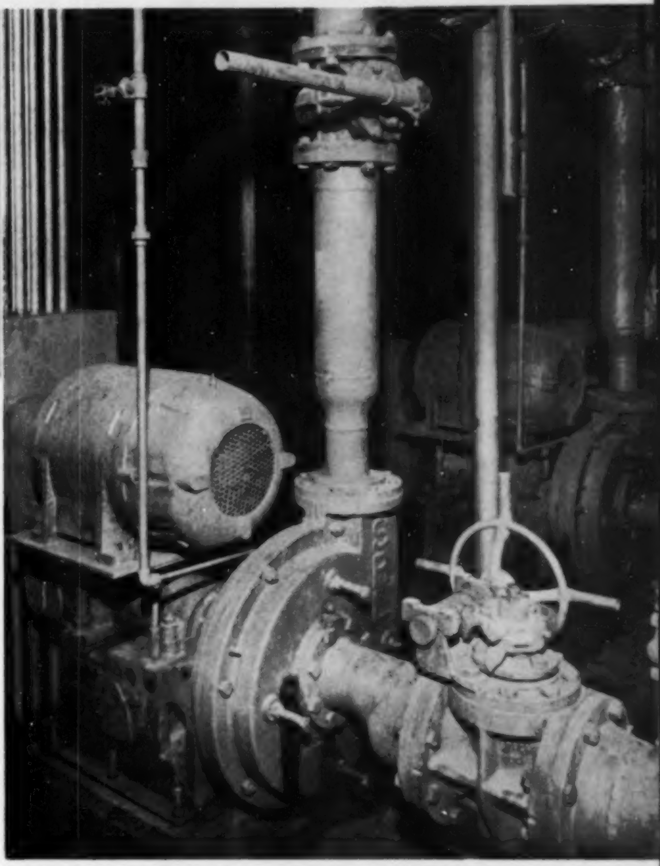

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